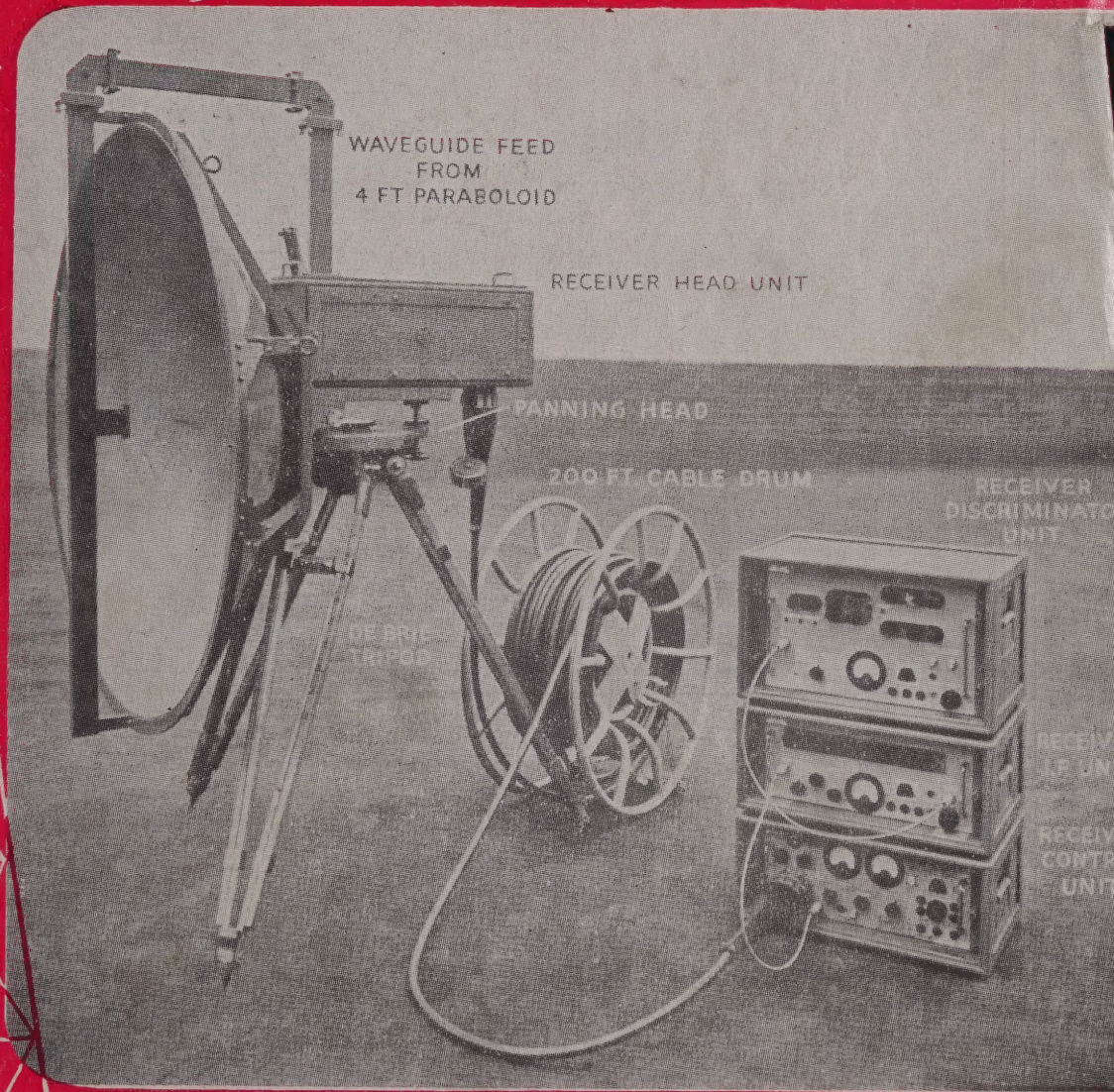
RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND



December 1st, 1952 VOL. 7, NO. 10. 1/10

Registered at the G.P.O., Wellington, for transmission by post as a newspaper

OSRAM VALVES

We are pleased to announce stocks of Osram Valves are now available for distribution to the retail trade at most competitive prices.

RECTIFIERS	5Y3G (U50)	6/– Retail
	5U4G (U52)	8/9 Retail
OUTPUT TUBES	KT66	20/6 Retail
	KT61	11/6 Retail
CRYSTAL RECTIFIER	GEX44/1	7/6 Retail

We carry a full range of both 6.3-volt and 1.4-volt miniatures as well as the usual octal types.

Write for data sheets and literature.

•

Osram Valves are manufactured by the General Electric Co., Ltd., England.

Green & Cooper Ltd.

RADIO ENGINEERS

Phone 54-418

Telegrams: "Fidelatone"

43 LOWER TARANAKI STREET, WELLINGTON

Radio and Electronics

VOL. 7, No. 10 December, 1952

OUR COVER

This month's photograph shows the external appearance of the receiving equipment belonging to the portable television link described in an article on Page 4 of this issue.

Official Journal of
The N.Z. Electronics Institute (Inc.).
The N.Z. Radio and Television Manufacturers' Federation.
The N.Z. Radio Traders' Federation.

Managing and Technical Director:
W. D. FOSTER, B.Sc.

Advertising Manager:
CHAS. H. ROSER

Subscriptions:
1s. 10d. per copy; 23s. per annum, posted.
Advertising Rates supplied on application.

CORRESPONDENCE
All correspondence and contributions should be addressed to:

The Editor,
"Radio and Electronics,"
P.O. Box 8022,
Wellington, N.Z.

OFFICES AND LABORATORY:
Radio and Electronics (N.Z.), Ltd.,
46 Mercer Street, Wellington.
Telephone, Wellington, 70-216.
Telegrams and Cables:
"Radel," Wellington.

SOLE ADVERTISING REPRESENTATIVES for THE UNITED KINGDOM:
Cowlishaw and Lawrence (Advertising), Ltd., 28 New Bridge Street, London, E.C.4.
Telephone City 5118.
Cables: Cowlawads Cent, London.

Contents

Page

Editorial 2

A Commercial Portable Television Link 4

A General-purpose Pre-amplifier for Low-level Pick-ups 5

A Simple Protection Device for Vacuum-tube Voltmeters 8

The Magnetic Amplifier 9

Tube Data: The R.F. Pentode EF80 (Part I) 12

Introduction to Radar Techniques, Part IV: The Radar Receiver, by the Engineering Department, Aerovox Corporation 17

Shoes and Ships: Speech Reproduction, by Special Arrangement with the Walrus 23

The Philips Experimenter—
No. 62: The Use of Ferroxcube in Radio and Allied Equipment 24

The *Radio and Electronics* Abstract Service 27

For the Serviceman: The "Pacemaker" Model 519P 29

Stolen Radios 31

Trade Winds 35

New Products: Latest Releases in Electrical and Electronic Equipment 40

Proceedings of the New Zealand Electronics Institute: Wellington Branch Embarks on a Television Project 43

Book Reviews:

Television, by Kerkhof and Werner 45

Elements of Radio Engineering, by H. I. F. Peel 45

Sole New Zealand Distributors: Gordon & Gotch (N.Z.) Ltd., Wellington

PRINTED BY HARRY H. TOMBS, LTD., WINGFIELD STREET, WELLINGTON.

What Of 1953?

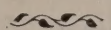
For the radio industry, as for a good many others, the year 1952 will probably be remembered as the year of credit control, with its attendant difficulties. Not that 1953 will probably be much easier in some respects, since the Government's policy will be felt by importers no less in 1953 than it was in 1952. However, it does seem that the radio industry can look forward to the new year not with foreboding, but with hope.

Early this year, those who expected to be affected in one way or another by the control of credit made no secret of their opinion that the country as a whole was in for a bad time, and while there is no doubt that the year has been a difficult one, there seems equally little doubt that now it is almost over, most of us have found it not quite so fearsome as we expected. The period of free importation may have been badly misused by many importers, but we do not believe that the importers of radio equipment were among their number. It is probably true to say that the importation of component parts was heavier during this period than at any other in the history of the radio industry, and that manufacturers' store-rooms are fuller than they have ever been, but this does not mean that the manufacturers and wholesalers have been deserving of the strictures that have been levelled at importers in other fields. The fact is that for the first time for years, the radio industry has had the chance to stock its shelves with large enough quantities of essential components to enable continuity of production to be assured. Such stocks hardly come under the heading of reckless buying; indeed, those manufacturers whose shelves are most laden with stock items that are becoming more difficult to procure now, will be in the fortunate position of being able to plan their production in the comforting knowledge that their schedules need not be disrupted, come what may.

As a result of all this, it is safe to say that whatever difficulties may confront importers and manufacturers in other lines, the radio industry will be able to continue to fill the public demand. But had the importers of components not made their hay while the sun shone, it is highly likely that not only new set production, but such things as the replacement valve market would have been starved before now.

And what of the demand? This question is of vital interest, because no industry can look with equanimity on a receding market. The latest Reserve Bank figures show that the retail sales of radio sets for the period January to July, 1952, are down on the corresponding figure for 1951. On the other hand, production in the factories for the same period has shown a rise. These facts, taken in conjunction argue a stock-piling in the wholesalers' warehouses, since it does not appear that retailers are holding large stocks. It should be pointed out, however, that the figures for the first seven months of the year do not necessarily provide a preview of the state of affairs at the end of the year. If, as we suspect, retailers have been keeping their stocks down to a minimum, and realizing on as much of their other stock as possible, in order to cope with the restriction in the credit which they have been allowed, it is more than likely that the final five months of 1952 will have seen a considerable clearing of wholesalers' stocks. It is thus not outside the bounds of possibility that the overall figures for the whole year will reveal that the volume of business done by the radio industry is no less than was done in 1951, in spite of the known tightening of the public's purse-strings. Should such turn out to be the case, the industry will be able to consider that it has done well in a difficult year.

Then what of 1953? So far, the season's wool sales have shown a substantial improvement over those of last year, and as long as the country's wool cheque remains a barometer of New Zealand's real prosperity, the indications are that 1953 should be a better year than 1952, even if the amount of money in circulation is still artificially restricted by the Government. But other things than overall prosperity can affect a specialized industry such as ours. Television, for instance. We believe that quite recently, a reporter on one of our larger daily papers expressed the opinion that television was a "dead duck." If he is correct, then the industry's keenness to come to grips with this newest challenge to its capabilities may be in danger of dispersing itself, but we do not agree with him. Our guess is that for the radio industry, 1953 will be a year of preparation for TV, and thus a forerunner of great things to come. We sincerely hope we are right. It would be a pity if, in the matter of TV, we were to lag too far behind such countries as Siam!



Christmas Greetings

NEW ZEALAND RADIO AND TELEVISION MANUFACTURERS' FEDERATION

In wishing all members of the New Zealand radio manufacturing industry and the New Zealand radio wholesale and retail trade the Season's Greetings, I would like to express a feeling of confidence in the future welfare of our industry. We are now all operating on a very stable basis, and this alone will ensure a successful year to come, but with the prospect of television within the reasonably near future, I believe that we can all look forward to an unprecedented period of prosperity ahead.

R. SLADE, *President.*

NEW ZEALAND RADIO TRADERS' FEDERATION

As the year 1952 draws to a close, may I take the opportunity through the courtesy of *Radio and Electronics* to extend the Season's Greetings to all connected with the radio industry. Let us all hope that the industry will continue to prosper and that 1953 will see further developments beneficial to the trader and public alike. A Merry Christmas and Prosperous New Year to all.

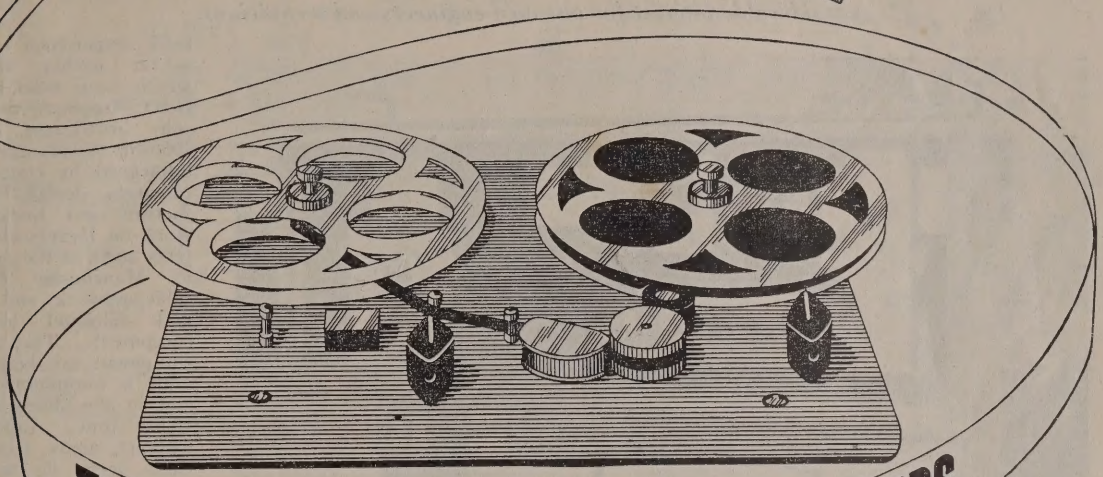
N. SOUPER, *President.*

WELLINGTON RADIO TRADERS' ASSOCIATION

The Christmas season is with us again and another year has slipped by. We hope that our many friends associated in the radio industry enjoy a prosperous trading season and that 1953 will be a prosperous one for us all.

W. M. YOUNG, *President.*

Qualitape



THE BEST BUY IN TAPE RECORDERS

★ **THE IDEAL GENERAL PURPOSE UNIT**

★ **LOW PRICE — GOOD QUALITY**

Available as a Complete Deck or in Kit Form (exclusive of tape). Will take 3M (Minnesota Mining and Mfg. Co.) tape or other standard tapes. Tape speed approximately 7½ inches per second. Extra pulley wheel can be supplied to increase speed for high fidelity. Working instructions, wiring diagrams, and suggested amplifier circuit included in kit. Deck available mechanically assembled requiring only wiring to motors and main switch which are provided, also record/playback head.

Sole N.Z. Distributors

SPECIFICATIONS

TOP PLATE: 12¾ in. x 10¾ in.; finished in Grey Crackle; overall depth, 5 in.

MOTORS: Two A.C. One direct drive on to capstan; other high-speed rewind.

CAPSTAN: Heavy solid brass. Engine turned in one piece, guaranteeing perfect accuracy; rotates on half-inch ball-bearing. Rubber drive fitted. Cemented and finally ground in position.

SPOOL SPINDLES: Of high-quality steel, revolving on solid gunmetal brackets on ball-bearing centres.

TAPE GUIDES: Finished in chromium.

MAGNETIC ERASE HEAD: Designed exclusively for Tape Recorder use.

RECORD/PLAYBACK HEAD: Low impedance; circular mumetal stacks of 0.008 thick laminations; built up to ¾ in.; wound to close tolerance and set in rubber with outer case finished in chromium.

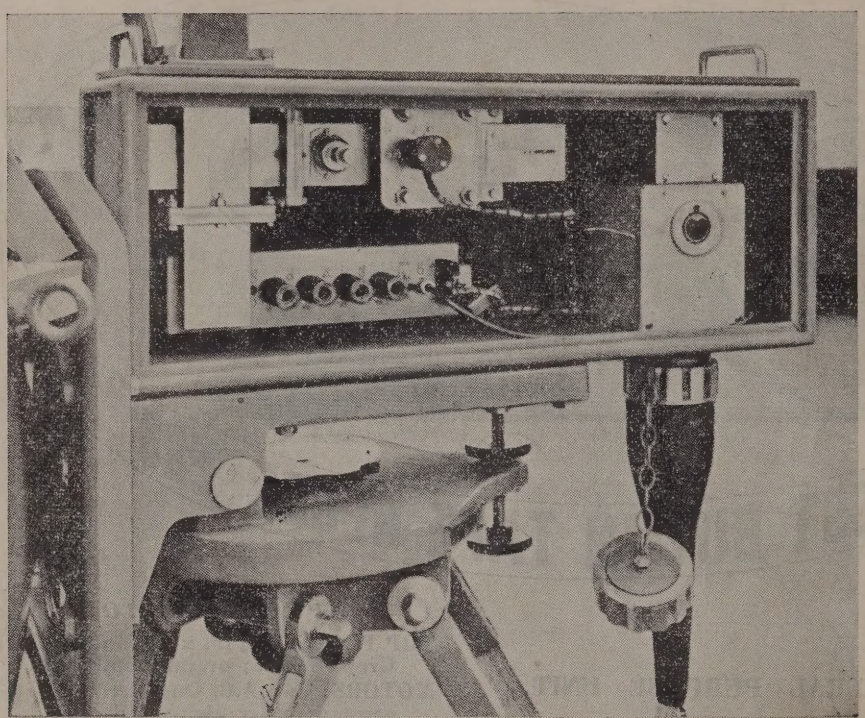
CLUTCH: Adjustable spring-loaded clutch on each spool.

TURNBULL & JONES LTD.

AUCKLAND WELLINGTON CHRISTCHURCH DUNEDIN HAMILTON
PALMERSTON NORTH INVERCARGILL

A Commercial Portable Microwave TV Link

In case anyone should think that Britain lags behind in the development of the most modern professional equipment in the television field, this equipment, recently announced by a British manufacturer, should easily dispel the notion. This is no experimental gear, demonstrated as a "stunt," but fully developed equipment capable of meeting the stringent requirements of television broadcasting as to performance and reliability. Although we in New Zealand have not yet got our own TV service, we are sure that descriptions, such as this, of the latest in TV equipment, hold considerable interest for our own engineers and technicians.



The portable microwave TV link comprises lightweight equipment forming a complete transmitter and receiver operating in the band 4400 to 4750 mc/sec. It has been developed primarily to meet the need in TV for a temporary link connecting the camera at an outside broadcast position to the permanent TV network, and operates over a line-of-sight path. The transmitter is designed to accept a signal band from 25 c/sec. to 5.5 mc/sec., thus covering the video signals sent direct from a camera. At the receiving terminal of the link, the corresponding output may be fed either (a) directly to a TV broadcast transmitter, (b) via a vestigial sideband system into a co-axial cable network, or (c) directly into the transmitter of a terminal or repeater station on a permanent TV microwave relay system.

In the same way, the receiver output of one portable link may be connected to the transmitter input of another link. This enables a limited number of portable links, each of which normally spans about 40 miles, to be connected in tandem. It also permits a deviation of route round obstacles which would otherwise be in the way of a single link.

The design of the portable microwave link is based on field experience gained with earlier models, which were used by the B.B.C. for numerous outside broadcasts during 1950-51. It has also been influenced by concurrent research, design, manufacture and installation work on large-scale projects such as the London to Manchester coaxial cable network, and vestigial sideband terminal equipment. The link equipment can be set up with a minimum effort, and in the shortest possible time. Individual weights, apart from the cable reels, do not exceed 59 lb. All bolts for assembly are captive, a single spanner being required for erection. Covers are retained in position by coin-slot fasteners. The antenna panning head is arranged to fit camera tripod legs. The antenna assemblies are designed to withstand all normal weather conditions, and can be used on a semi-permanent basis if desired.

TECHNICAL FEATURES

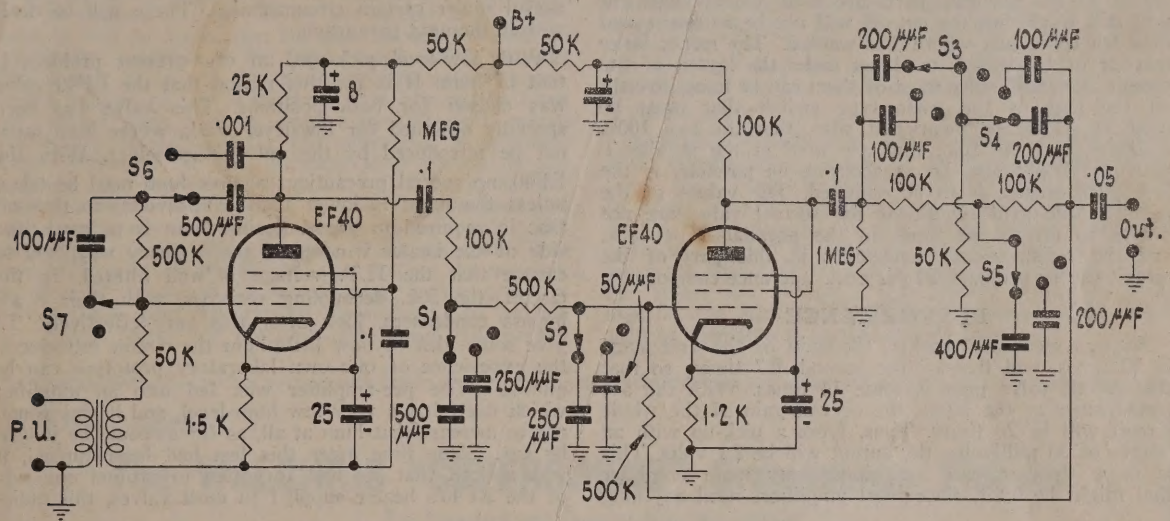
The transmitter uses a velocity-modulated coaxial line valve (travelling-wave tube) delivering a power of 250 milliwatts into the 4 ft. diameter parabolic reflector. The transmitter is frequency-modulated, with a deviation of 4 mc/sec., which can be extended to 8 mc/sec. for use under difficult transmission conditions. The intermediate frequency of the receiver is 30 mc/sec., and has a bandwidth of 20 mc/sec.

The receiver comprises a crystal mixer, fed from a receiving paraboloid identical with that of the transmitter, and provided with local-oscillator voltage from a travelling-wave tube similar to that used as the transmitter. The frequency-modulated I.F. of 30 mc/sec. is then amplified in a four-stage low-noise I.F. pre-amplifier using grounded-grid triodes, and is then fed through cable to the power and control unit, which contains all the stabilized power supplies, and all the necessary controls and meters. From the control unit ,the I.F. is fed to an I.F. unit consisting of ten amplifier stages, including three staggered triples, with automatic and

(Continued on Page 48.)

A General-Purpose Pre-Amplifier for Low-Level Pick-ups

Of recent months, several gramophone pre-amplifier circuits have been presented which employ simple switching to enable the correct compensation to be chosen for either standard or long-playing records. Most of these arrangements have been unsuitable for low-level pick-ups, but the present circuit is presented in order to fill the gap.



INTRODUCTION

During the course of this year, *Radio and Electronics* has been at some pains to cater for the tremendous interest that is now apparent in gramophone reproduction, especially since we have been favoured with a plentiful supply of long-playing records. However, most of the circuits we have published have been suitable only for high-level pick-ups, and would probably need a further stage of amplification if they are to be used with low-level ones. There are on the market at present, one or two excellent pick-ups with output in the vicinity of only 30 to 40 millivolts. It is to cater for these pick-ups that the present circuit is printed.

OPERATIONS PERFORMED BY THE PRE-AMPLIFIER

The first essential of a pre-amplifier, of course, is to amplify. This the circuit does, so as to give a maximum output of approximately 1.5 volts, peak, from the kinds of pick-up mentioned above. At the same time, it modifies the response from the normal "straight and level" to one which compensates for the fact that the records we play do not themselves have a flat response. It does this for both 78 r.p.m. recordings, and the newer long-playing records, which require different treatment from the standard records. Accordingly, a selector switch is provided, which enables the correct compensation to be chosen for either type of record.

The remaining portion of the circuit—that of the second valve, uses a circuit similar to one first described by Williamson, of amplifier fame, for limiting the high-frequency response of the whole system. This is to take care of old or badly worn 78 r.p.m. discs, which sound unpleasant, owing to the high scratch level, if reproduced on wide-range equipment. A second selector switch is used, to select either a flat response, one which drops off sharply at 10,000 c/sec., or one which drops off just as sharply at 5000 c/sec.

CIRCUIT ARRANGEMENTS

One of the types of pick-up to which we have referred above can be purchased with a step-up transformer, specially designed for it by the makers. It has a ratio of five to one, so that the output from the pick-up itself of approximately 30 millivolts is stepped up to 150 millivolts at the secondary of the output transformer. The first stage of amplification employs a pentode-connected EF40, which acts at the same time as the frequency response compensator. Its overall gain is reduced to approximately 20 times by the negative feedback that is connected round it in order to enable the frequency compensation to take place.

The frequency compensation itself is obtained by placing frequency-dependent elements—all of which are small condensers—in the feedback loop in such a way that the negative feedback decreases in regions where a rise in response is desired, or increases in regions where a falling-off in response must be provided. Switching from 78 to L/P is accomplished in a very simple manner by altering the values of the condensers referred to above.

The second valve is concerned solely with producing the sharp cut-off characteristic, and gives no overall amplification at all. Indeed, it gives a slight loss, but this is small, the output being approximately two-thirds of the input voltage at its grid. The circuit is such that when the sharp cut-off is not required, the gain of the second stage is constant, so that operating the switch which governs the cut-off frequency has no effect at all on the apparent volume. We do not intend to give a

lengthy description of the working of this circuit, as this has been fully described elsewhere (*Radio and Electronics*, February, 1951; the Williamson Amplifier reprints from *Wireless World*). It requires a five-pole three-position switch, and entails quite a bit of wiring, but builders will find no difficulty in making it work. The only tips that can be given about this circuit are to make the condensers in the parallel-T network, which follows the valve, as accurate as possible. If 1 per cent. tolerance components can be used here, so much the better. If less accurate parts are used, the arrangement will still work, but the cut-off will not be so sharp, and may not come just where it is wanted. The rather large number of condensers need not make the layout of the circuit awkward, since most of them can be hung directly on the lugs of the wafer-type switch that must be used. It should be mentioned, also, that the two 100k. resistors, and the 50k., that are used in the parallel-T network should also be as accurate as possible, if the best performance is to be obtained. The values of the parts in the grid circuit of the second valve are not nearly so critical as those in the parallel-T network, and the resistors and condensers in this part of the circuit can be ordinary 20 per cent. tolerance components.

PERFORMANCE

As was mentioned earlier, the gain of the first stage is 20 times, and that of the second, 0.7 times, so that the overall valve gain is some 14 times. With the 5:1 transformer at the input, the overall gain of the whole circuit will be 70 times. Thus, from a pick-up with an output of 30 millivolts, the output will be 2.1 volts. This is more than enough for almost any main amplifier that might be built, since most amplifiers need anything from 0.5 to 2.0 volts at the input for full output power.

From a pick-up with an even lower output, such as 12 millivolts, the output would be 0.84 volts, which would again be ample for almost any amplifier. However, not all users will want to employ an input transformer, so that it will be useful to explore the possibilities of the pre-amplifier if it is used without the transformer. Similarly, not everyone will need the sharp cut-off filter feature, so that a number of possibilities arise for simple modifications that could be useful under certain circumstances. These will be dealt with in the next paragraph.

With low-level pick-ups, an ever-present problem is that of hum. It is for this reason that the EF40 valve was chosen for both positions. This valve has been specially designed for low-level work, where hum must not be introduced by the valves themselves. With the EF40, no special precautions against hum need be taken unless the input is lower than 5 millivolts, so that all that is required to guard against hum is to earth one side of the heater winding in the ordinary way, and to ensure that the H.T. voltage is well filtered. In the circuit, the 50k. decoupling resistors, with their 8 μf. bypass condensers, look after this very effectively. To give some idea of how little hum the circuit introduces, the experience of our own laboratory prototype can be quoted. The pre-amplifier was fed into an amplifier which itself has a very low hum level, and it was found not to increase that hum at all, as far as could be judged by ear. Some time *after* this test had been applied, it was noticed that we had forgotten to ground one side of the EF40's heater supply! In most valves, this omis-

Available Soon!

RADIOTRON DESIGNERS' HANDBOOK

★ 1,500 PAGES ★ 1,000 ILLUSTRATIONS ★ SIZE 8¾ x 5½

PRICE 55/- (Plus 2/6 post) **4th EDITION**

PRE-PUBLICATION ORDER FORM

AMALGAMATED WIRELESS (AUSTRALASIA) LTD.
G.P.O. Box 830
WELLINGTON, N.Z.

Sirs,

Please forward immediately on publication ..... copies of RADIOTRON DESIGNER'S HANDBOOK, 4th EDITION, for which find enclosed .....
plus 2/6 per copy, Packing and postage.

NAME (Please Print): Mr. .....

ADDRESS: No. ..... *STREET* .....

TOWN .....

sion would be enough to introduce enough hum to make the circuit quite useless.

POSSIBLE MODIFICATIONS

If the input transformer is omitted, the pick-up can be connected in the circuit directly in place of the transformer secondary. This will have no adverse effect on the performance, except that the gain of the transformer will not be there. For a 30-millivolt pick-up output, the output from the first stage will then be 0.6 volts. This will be reduced to 0.42 volts by the second stage. However, it will be found that the gain is still sufficient to enable any amplifier to be fully loaded which requires half a volt or less at the input for full output power. For a pick-up of the 12-millivolt class, the output from the second stage will be only some 0.16 volt, which will hardly be sufficient for full output for most amplifiers. However, if the low-pass filter circuit is not required, the second EF40 can be used as a straight triode-connected amplifier. To do this, the plate load and cathode bias resistors can remain of the same value, and the output can be taken straight from the plate. The parallel-T network can be abolished, as can the network in the grid circuit of the second stage. In the grid circuit, a 500k. grid leak can be placed so as to provide D.C. earth return for the grid. This stage will have a gain of approximately 29 times, so that with the 12 mv. pick-up, the output would now be up to just under 7 volts. There would thus be no danger of the second stage being overloaded by the first, and the output would be more than could possibly be required for any ordinary amplifier. With this set-up, it might be advisable to lower the gain a little by omitting the cathode bypass condenser on the second stage. This would reduce its gain to just over 20 times, and the output to about 4½ volts In order to reduce the output voltage fed to the main amplifier, the plate load resistor of the second stage could be split into two parts, say 20k. and 80k. in series. The 20k. resistor would be placed at the H.T. end, so that when the output is taken from the junction between the two resistors, only a fifth of the output is picked off.

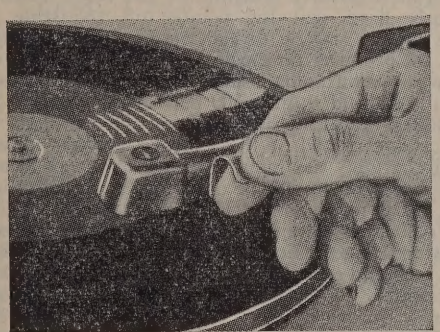
A further modification, which might be desirable in some circumstances, would be to install a cathode follower stage after the second amplifier stage. This could be done, without adding any more valves, by using a double triode instead of the second EF40. The valve could be a 6SN7, in which case the gain would be lower when the first half was to be used as a straight amplifier stage, and no lower than before if it was to be used as the sharp-cutoff filter. The second half would then be available as a cathode follower.

First Again !

The WALCHRIS "SUPERSOUND" Gramophone Pick-up

For Standard and Long-playing Recordings

HIGH FIDELITY PLUS HIGH OUTPUT



- Flat response 20-17,000 cycles.
- Output up to 1 volt, eliminating preamplification and greatly simplifying circuit design.
- Robust entirely new design of three-pole MAGNETIC featherweight head, 1/3 oz.
- High impedance; no coupling transformers necessary.
- Plug-in Heads of superior design, instant positive snap-lock contact.
- Two types of Plug-in Heads available. WALCHRIS offers the choice of: (1) Standard 78 r.p.m.; (2) Long-playing.
- All sapphires are rubber cushioned and retractable, eliminating damage to both needle and recording if accidentally dropped or pushed over record.
- Acoustic noise from pick-up eliminated to a degree never previously experienced.
- **Price: Ball-bearing Arm and 78 Head, £6/8/-; Microgroove Head, £5.** There is nothing to compete with the WALCHRIS. Compare it and be satisfied. You will be delighted with WALCHRIS reproduction.

PRINCIPAL STOCKISTS:

Barnaby's Radio House, Whangarei.
Lockyers Ltd., Napier.
Guy E. Milne, Hastings.
Paul Barcham, Hastings.
Skilton's Radio Supplies, Palmerston North
Baden Winchcombe Ltd., New Plymouth.
Walker Electric Co. Ltd., Wanganui.
Fairclough's Radio, Wanganui.
Midway Music Store, Gisborne.
Radio Sound and Service Ltd., Wellington.
Electric Lamphouse Ltd., Wellington.
L. D. Hepburn Ltd., Christchurch.
Eclipse Radio Ltd., Dunedin.
Arnold Grubb Ltd., Gore.
J. W. Longstaffe. Invercargill.
Roy Stewart, Irk Street, Gore.

TRADE INQUIRIES INVITED

W. S. GREEN & CO., LTD.

C.P.O. BOX 2303, WELLINGTON TELEGRAMS: "GREENAGE" PHONE 36-929

A Simple Protection Device for Vacuum-tube Voltmeters

Many vacuum-tube voltmeters at present in use suffer from one serious drawback. It is possible to send the pointer violently off-scale, to the detriment of the meter movement, especially when the A.C. voltage to be measured is at a point on the circuit where a considerable D.C. voltage appears at the same time. The simple device described here will be found applicable to many instruments, and effects a fairly complete cure.

INTRODUCTION

Some time ago, in the May and June issues, 1951, of this journal to be precise, we described a vacuum-tube voltmeter circuit which has a considerable vogue among our readers. The arrangement used consisted of a diode rectifier, whose D.C. output voltage was measured by a direct-coupled, balanced valve-voltmeter circuit. The basic arrangement was as shown in Fig. 1. V_1 is the signal rectifier, while V_2 and V_3, the halves of a 6SN7, operate the meter M. V_3, and the other diode, V_4, are purely balancing devices, used to counteract the effects of contact potential and of varying supply voltages.

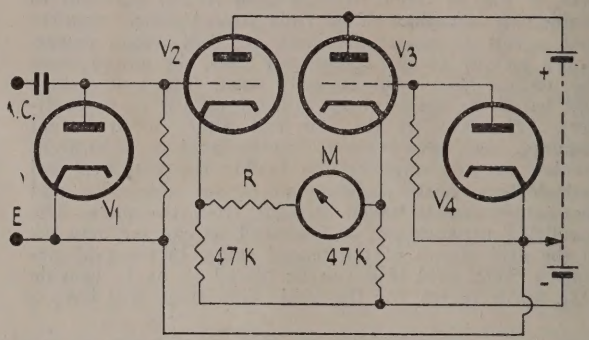
One difficulty with this, and many other vacuum-tube voltmeter circuits, is that when the diode probe is attached to a point where there is a considerable D.C. potential, as well as the A.C. voltage it is desired to measure, a large surge of voltage is applied to the grid of V_2. If, therefore, the meter is switched to a low voltage range, this surge will frequently be great enough to drive the pointer hard up against the stop. To avoid this, it is essential to keep the instrument on the highest voltage range, and to remember not to switch it to a low range until after the probe has been connected to the measuring point. By the same token, when the input condenser of the probe has been charged up by connecting it to the test point, a further voltage surge will be caused if the probe is suddenly discharged, through touching it with the fingers, or through earthing it preparatory to adjusting the zero for the next reading.

The following remedy was suggested to the writer by Mr. R. J. Dippy, and has been found to be very effective.

A REMEDY FOR THE TROUBLE

The cure is exceedingly elegant in its simplicity, as is often the case with good ideas. It consists of connecting a small condenser between the grids of V_2 and V_3, and it works in the following way. The voltage surge is applied directly to the grid of V_2, as before, and through the condenser, to the grid of V_3. If the condenser is made large enough to act as an efficient coupling condenser, there will be very little attenuation of the voltage pulse, so that essentially identical voltages are applied to both grids. Moreover, these voltages are in the same phase. If the pulses are negative, they should result in both grids being driven in a negative direction at the same time, so that however large the pulses may be, there will be no difference of potential between the cathodes of V_2 and V_3. As a result, there should be no potential difference developed between the terminals of the meter, which will not deflect.

The condenser can have no effect on the reading of the meter to desired signals, which take the form of a difference of potential between the grids, because the signals are D.C. ones. The only possible effect is that which would take place if the condenser were made very large in size. In this case, the meter could not take up its proper deflected position until after the condenser has been charged up through the grid circuit of V_3, so



that there would be a delaying effect on the movement of the pointer. In the case of a poorly damped meter movement, it seems likely that the effect could be exploited in order to supply the necessary damping.

RESULTS OBTAINED

A trial of the suggested scheme showed that when the probe was connected to a point of positive potential, such as the plate of a valve, the device was entirely successful. A positive potential of 250 volts, which would previously have sent the pointer off the scale, except on the highest range (which measures 300 volts) was found to produce no positive meter deflection at all. This was encouraging, since the added condenser can truthfully be said to give 100 per cent. protection against the sudden application of a positive voltage to the probe. However, when the charged probe was earthed, thus discharging the input condenser, it was found that a quite large upward kick occurred. This deflection was not as great as is found when the condenser is absent, but is still large enough to drive the pointer off-scale on the lower ranges. For example, with the probe condenser charged up to 250 volts, an upward kick of approximately 30 volts was obtained when the probe was connected to earth. This behaviour has not yet been explained, as there seems no good reason why the condenser should not give just as good protection against connection of the probe to a negative potential as to a positive one. After the probe has been charged up by a positive voltage, and is then discharged by connecting it to earth, the effect was found to be exactly the same as when the uncharged probe was connected to a negative potential. It appears that in some way that is not apparent, there must be some impedance which is not common to both triodes, otherwise there is no reason why any voltage surges taking place in the circuit should not affect both triodes equally. And if this is so, the cathodes must remain very close to each other in potential, making it impossible for the meter to be deflected.

This is a very interesting problem, to which it is hoped to obtain an answer, with a view to effecting a complete cure to the voltage surge problem. It may well be that

(Continued on Page 48.)

The Magnetic Amplifier

Since the close of World War II, the magnetic amplifier (also called the transductor) has attracted a steadily increasing amount of attention in private electronic circles. This has been due in large part, perhaps, to a carry-over of wartime interest in the device for control purposes in military equipment. Today, a host of applications in private industry suggest themselves.

Although the magnetic amplifier is a simple, tubeless device, it affords useful power amplification which in some cases is tremendous. Because it requires no tubes and can be operated with a straight A.C. power supply, it needs little or no maintenance and is capable of instant operation.

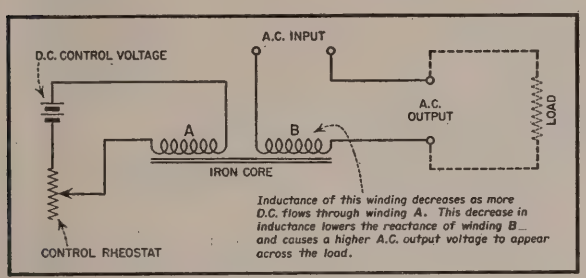

A.C. INPUT
D.C. CONTROL VOLTAGE
A.C. OUTPUT
LOAD
A
B
IRON CORE
Inductance of this winding decreases as more D.C. flows through winding A. This decrease in inductance lowers the reactance of winding B and causes a higher A.C. output voltage to appear across the load.
CONTROL RHEOSTAT

Fig. 1. Saturable Reactor Principle.

We are presenting a single explanation of the magnetic amplifier because we believe that this device will be encountered more frequently in future radio and electronic equipment and that its principle of operation therefore should be understood by radio and electronic technicians.

BASIC OPERATING PRINCIPLE

The magnetic amplifier owes its existence to the simple saturable reactor. Most radio men are familiar to some extent with saturation in reactors. They understand, for example, that the inductance of an iron-core choke coil is lower when a direct current flows through the coil than when no D.C. is present. (One commercial audio choke intended for impedance coupling in pentode plate circuits has an inductance of 200 henries when no D.C. is present in its coil, and only 50 henries when 2 milliamperes D.C. flow through it). This ability to change the inductance of an iron-core coil (and consequently its reactance and impedance to A.C.) by passing a direct current through the coil is the basic mechanism of the magnetic amplifier.

Figure 1 shows a rudimentary saturable reactor arrangement for explanatory purposes. Two windings, A and B, are situated on the same iron core, in the manner of a standard transformer. A constant-level A.C. voltage is applied in series with winding B and a load device, such as a resistance. Winding B thus acts as a series reactor in this circuit and can limit the value of the A.C. output voltage. The A.C. output voltage is equal to the A.C. input voltage minus the voltage drop in winding B (vectorially). The reactance of winding B depends upon the inductance of this winding, and that in turn depends upon the size of the winding and the nature of the core material and its condition. If the core is "premagnetized" (for example, by passing a steady direct current through winding A), the inductance and reactance of winding B will not be as large as when no current flows through A. The result is that winding B will offer less impedance to the applied A.C. input voltage, and the A.C. output voltage will increase. Up to a certain point determined by the magnetic properties of the core material, the more direct curent flowing in winding A the higher will be the A.C. output voltage.

By properly proportioning windings A and B and the A.C. and D.C. voltages, and by selecting properly the core material, it should be possible to vary the A.C. output voltage over a range extending from nearly zero to a maximum value. Also, it should be possible to use a relatively small amount of D.C. power to control a rather large A.C. power. This, of course, amounts to power amplification, and when it can be accomplished

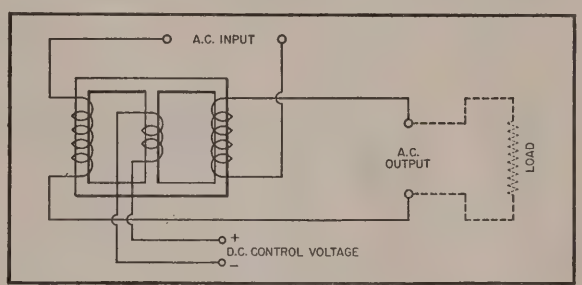


Fig. 2. 3-Leg Saturable Reactor.

with apparatus of the type just described, a magnetic amplifier results.

While the illustration in Figure 1 serves to explain the principle of the saturable reactor which is at the basis of the magnetic amplifier, it has necessarily been over-simplified. Some difficulties would, of course, be experienced with such rudimentary equipment. For example, the amount of magnetization obtained from winding A would not be great unless the core were of the size and material to give good efficiency. Also, the transformer action would cause an A.C. voltage to be induced from winding B across the terminals of windnig A. This induced voltage very likely would interfere with application of D.C. to winding A.

A practical form of saturable reactor, such as is found in industry, is shown in Figure 2. Here a special 3-legged core is used. The A.C. winding is divided into halves, one being wound on each outside leg of the core. The two halves of this winding are connected in series aiding. The D.C. control coil is wound on the centre leg of the core.

With this arrangement, no A.C. is induced in the D.C. coil because the magnetic flux arising from the A.C. coils extends around the rectangle of the core but not through the centre leg. Flux due to D.C. flowing through the control coil, however, extends from the centre leg through both outer legs and accordingly can affect the reactance of the A.C. coils. This forms a saturable reactor of the type which has been employed for a number of years for theatre light dimming, motor control, relay operation, and for tuning-light operation in radio receivers. This is a form of magnetic amplifier, since with proper design the controlled power may be large compared to the controlling power.

Figure 3 shows a simple saturable-reactor-type amplifer or control circuit utilizing two small winding transformers. This arrangement has been popular with students and experimenters. Miniature transformers having nickel alloy cores are especially suitable for this

application, since such transformers are not designed to handle appreciable direct current and therefore are readily susceptible to the D.C. control current.

The D.C. control voltage is applied to the two secondary windings (A and B) which are connected in series bucking. This opposing type of connection cancels any A.C. induced by the windings C and D, preventing its being forced through the D.C. source. The A.C. supply votlage is applied in series with the primary windings C and D (which are connected in series aiding) and the load.

The Swedish engineers Hedstroem and Borg have shown a circuit* in which the core is presaturated in order to position the point of operation along an advan-

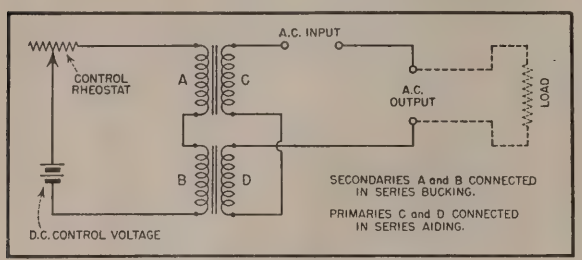


Fig. 3. Transformer-type Magnetic Amplifier.

tageous part of the permeability curve of the core material. In order to prevent having to use a separate presaturating winding and D.C. source, a portion of the A.C. supply is rectified by two metallic rectifiers and used for this purpose. A form of this circuit is shown in Figure 4. Selenium rectifiers normally are employed, but germanium diodes might be used for light-duty applications.

Two interesting applications of feedback to magnetic amplifiers are shown by Vickers† and are illustrated in Figure 5. In each of these circuits, a separate winding is provided for feedback. Direct current for this feedback winding is obtained from a full-wave bridge rectifier composed of metallic cells or diodes and operated in series with the amplifier load. Figure 5 (A) shows a feedback amplifier circuit which delivers D.C. output to the load. This then is a D.C. amplifier. Figure 5 (B) is a similar circuit which delivers A.C. to the load. In each of these drawings, only coils are shown. The core has been omitted for simplicity of reading.

Depending upon the polarity of the feedback winding, either positive feedback (regeneration) or negative feedback (degeneration) can be obtained. The effect of regeneration is to increase the sensitivity of the amplifier to small changes in the D.C. control voltage. The effect is to make the response more linear and to increase stability, although (as in electronic amplifiers) degenerative feedback reduces the sensitivity somewhat.

Any of the conventional magnetic amplifier circuits may be used as an A.C. amplifier by rectifying the A.C. signal voltage, applying the resulting D.C. to the D.C. control winding, and taking A.C. output from the amplifier. Similarly, a D.C. amplifier may be made by feeding the D.C. signal voltage directly into the control winding, and rectifying the A.C. output of the amplifier. The third type of operation which perhaps is most common in magnetic amplifier usage (and which is employed almost exclusively for control operations) con-

*Transductor Fundamentals. Hedtsroem and Borg. Electronics, September, 1948. p. 88.

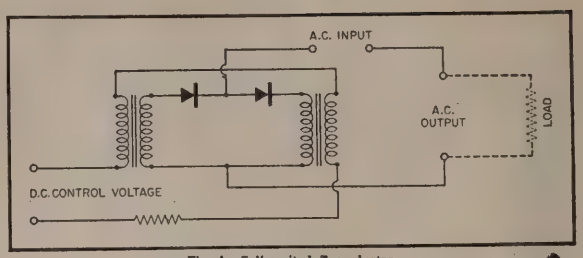


Fig. 4. Self-excited Transductor.

sists of applying a D.C. control voltage and taking A.C. output from the amplifier.

Magnetic amplifiers may be operated in cascade, in the same manner as tube amplifiers, in order to obtain higher gains. They also may be operated in push-pull.

Only basic circuits are shown in this article, since our discussion is of an introductory nature. We will not touch upon polyphase magnetic amplifiers nor show multi-stage circuits.

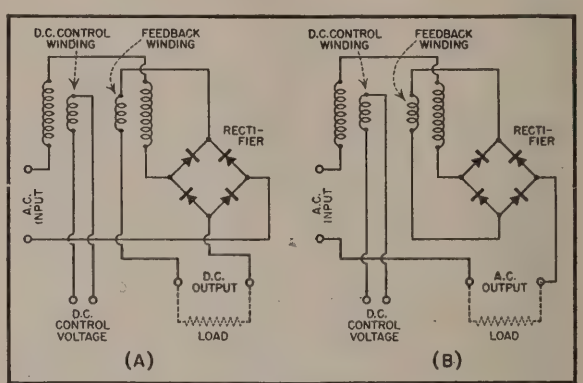


Fig. 5. Feedback Amplifiers.

MAGNETIC AMPLIFIER APPLICATIONS

The magnetic amplifier has no moving parts; and since it has no tubes which must heat up slowly, it is ready for operation as soon as it is switched on. Mechanically rugged, it can withstand considerable abuse. In most installations, the magnetic amplifier is no more bulky nor unconventional in appearance than any iron-core transformer or choke of similar ratings. Replacement and maintenance costs are low for this device.

The magnetic amplifier has the disadvantages that it does not have the speed of operation of the electron tube amplifier or control circuit. Its speed depends upon inductance and frequency. The magnetic amplifier places a load upon the control-signal source, since it draws current for control. Its high frequency limit is governed by the electrical and magnetic characteristics of the core material. It is expected that newly developed core materials may extend the operating range ultimately into the radio-frequency spectrum.

Within the limits of its operation, the magnetic amplifier provides exceptional stability in both A.C. and D.C. applications. Hedstroem and Borg* report power amplifications as high as 100 million. The magnetic

(Continued on Page 48.)

†Magnetic Amplifiers. (Bulletin No. VT-2000). Vickers, Inc., St. Louis, Mo. pp. 6, 7.

Seasons Greetings

from

BEACON RADIO LIMITED

We wish to thank our many customers for their valued business during 1952, and hope to be able to give even greater service now that we are established in our new factory.

Best Wishes

for

1953

If you are not served by one of the Wholesale Distributors mentioned below, please get in touch with us direct.

WELLINGTON:	TARANAKI:	OTAGO:	CANTERBURY:
Green & Cooper, Ltd.,	J. B. MacEwan & Co., Ltd.,	R. H. Gardner,	Arnold & Wright, Ltd.,
43 Lower Taranaki Street,	King Street,	42 Crawford Street,	126 Lichfield Street,
WELLINGTON	NEW PLYMOUTH	DUNEDIN	CHRISTCHURCH

BEACON RADIO LIMITED

Cnr. Brown and Fitzroy Streets, Ponsonby, Auckland

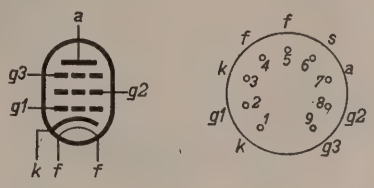
MANUFACTURERS OF DRIVER AND MODULATION TRANSFORMERS, Etc.

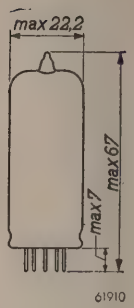
TUBE DATA: The R.F. Pentode EF80

DESCRIPTION

The EF80 is a high-slope R.F. pentode on the Noval base, designed primarily for wide-band R.F. and I.F. amplification in television receivers. Its characteristics render the tube suitable for use also as a video amplifier in receivers of a simple type, as a frequency changer, and in some forms of synchronizing-pulse separator circuits.

As with other tubes in the range described previously, the EF80 can be used with an H.T. line voltage of 170v. without sacrificing performance. A line voltage of about 170v. is commonly encountered in television receivers with a transformerless supply system when the mains voltage is 220v. Due to the provision of two cathode leads, the input conductance has been reduced, and this





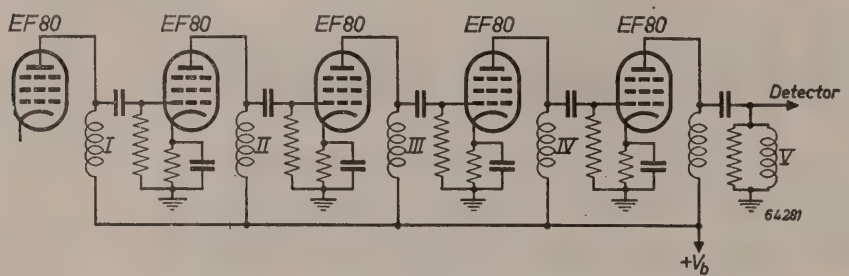


Fig. 1.—Basic diagram of a four-stage stagger-tuned I.F. amplifier.

is of particular importance at the higher frequencies in the television bands.

APPLICATION

1. The EF80 as I.F. Amplifier

The carrier frequencies of the low television band for channels I to IV of the 625-line system lie between about 40 and 70 mc/sec. Two possible circuit arrangements are available for the amplification of these signals to a level suitable for video detection. In receivers intended for the reception of one channel only a T.R.F. amplifier can be used but, owing to the high carrier frequencies, efficient screening is required, whilst it is also difficult to adapt such a receiver for the reception of more than one channel, if this should become necessary. A superhet arrangement is therefore often preferred and most of the gain is then provided by the I.F. amplifier, the preceding stages mainly serving for frequency conversion and some pre-selection. Moreover, the frequency response of the R.F. part of the receiver is usually very flat, so that the shape of the response curve of the receiver is almost entirely determined by the I.F. circuits.

A normal figure for the required I.F. signal at the video detector for average picture contrast with a direct-viewing picture tube and one stage of video amplification is 2v. Assuming that one stage of R.F. amplification and a frequency changer are employed, giving a total gain of 20 between the aerial terminals and the grid of the first I.F. tube, a total I.F. gain of 10,000 is required when the sensitivity for the centre frequency of the pass band has to be 10μV, and one of 1000 when a sensitivity of 100 μV is considered sufficient. A convenient figure for the 3 db bandwidth with the 625-line system is 5 mc/sec. and, in order to keep image frequencies outside the television band and to minimize feedback of harmonics of the detected I.F. signal into the first stages of the receiver, the centre of the I.F. band should be chosen at about 21 mc/sec.

A basic diagram for a four stage stagger-tuned I.F. amplifier is given in Fig. 1. A very useful characteristic quantity of a tube is the product of gain and bandwidth, GB, which is equal to $S/2\pi(C_i + C_o)$, in which S is the static mutual conductance and C_i and C_o are the input and output capacitances respectively. With the EF80 this figure is 100 and this would imply that a voltage gain of 22 could be achieved when the 3 db bandwidth of the anode circuit is 5 mc/sec. However, the GB figure is a typical tube characteristic and therefore does not take into account the unavoidable increase in total capacitance of the anode current caused by the wiring and the distributed capacitance of the coil. Moreover, the GB figure is given for the cold capacitance of the tube, and for a tube in operation the actual capacitances are somewhat greater. A practical figure for the product G · B of the EF80 is 55 when the capacitance in the anode circuit is not intentionally increased, which implies tuning of the circuits by means of slugs of powdered iron. A stage gain of 11 can therefore be obtained when the bandwidth is 5 mc/sec. This method of calculation may also be applied to a stagger-tuned amplifier when the circuits are mutually detuned and damped according to the method of flat staggering.* A four-stage amplifier with EF80 will by means of slugs of powdered iron. A stage gain of 11 can therefore be obtained when the bandwidth is 5 mc/sec. This method of calculation may also be applied to a stagger-tuned amplifier when the circuits are mutually detuned and damped according to the method of flat staggering.* A four-stage amplifier with EF80 will therefore provide a total I.F. gain of 10,000 and one with three stages a total gain of 1000. With these figures allowance is made for some decrease in gain due to the inclusion of trap circuits for the suppression of sound,

*See *A. G. W. Uitjens,* Fundamental Problems of H.F. and I.F. Amplifiers for TV Reception, Part I: Gain and Bandwidth, Electr. Appl. Bull. *11,* p. 205, 1950 (No. 11).

adjacent sound and adjacent picture signals. Also the inclusion of small non-bypassed cathode resistors, for compensating the variation of the input capacitance of the tubes caused by the contrast control, will result in a somewhat lower gain. A simple method for determining the tuning frequencies of each of the five tuned circuits of the four-stage amplifier of Fig. 1 and the required bandwidths of each circuit will now be given.

From a semi-circle, subdivided into 5 equal parts, a perpendicular is dropped to the diameter from the centre of each part (see Fig. 2). The scale of this figure should be so chosen that the diameter represents the required 3 db bandwidth of the whole amplifier, which in our case is 5 mc/sec. The base of the central perpendicular now represents the centre of the I.F. band and the horizontal distances of the other perpendiculars represent

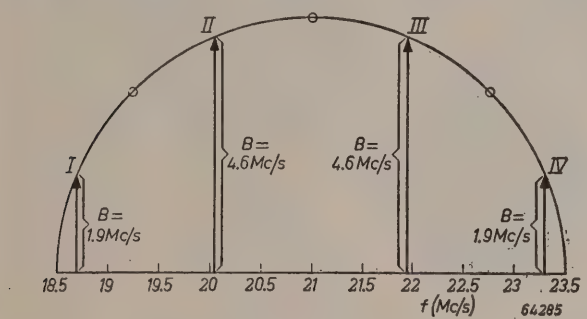


Fig. 2.—Stagger diagram for a four-stage I.F. amplifier centred at 21 mc/sec.

the detuning of the other circuits with respect to the centre. Moreover, the length of each perpendicular gives half the required bandwidth of each circuit. The tuning frequencies and bandwidths of the circuits of Fig. 1 may now be tabulated as follows:

Circuit No.	Tuning frequency	Bandwidth
I	18.6 mc/sec.	1.6 mc/sec.
II	19.5 mc/sec.	4 mc/sec.
III	21 mc/sec.	5 mc/sec.
IV	22.5 mc/sec.	4 mc/sec.
V	23.4 mc/sec.	1.6 mc/sec.

The staggering scheme for a three-stage I.F. amplifier also with a bandwidth of 5 mc/sec. and a centre frequency of 21 mc/sec. is represented in Fig. 3. Such an amplifier with three EF80 tubes provides a gain of 1000 and the stagger frequencies and bandwidths are:

Circuit No.	Tuning frequency	Bandwidth
I	18.7 mc/sec.	1.9 mc/sec.
II	20.05 mc/sec.	4.6 mc/sec.
III	21.95 mc/sec.	4.6 mc/sec.
IV	23.8 mc/sec.	1.9 mc/sec.

From this staggered diagram it appears that it is not always necessary to have a circuit tuned to the centre frequency. In fact such a circuit will only occur in an amplifier having an uneven number of tuned circuits.

The required bandwidth of each individual circuit is usually obtained in the following way. All coils of the amplifier are given equal Q's and the bandwidth of each circuit is adjusted to the desired value by choosing a suitable value for the grid leak resistor (Fig. 1). In determining the value of this resistor it is not necessary to take the input damping of the EF80 into account, this damping having a very favourable value. The damping on the last I.F. circuit caused by the detector diode, however, may be quite considerable, its value being approximately equal to the diode load. When the smallest bandwidth of the circuits is obtained from the stagger diagram the minimum Q of the coils may be calculated with the aid of the following formula:

$$Q = \frac{f_o}{B}$$

in which f_o is the tuning frequency of the circuit in question and B the bandwidth. For instance, the minimum Q of circuit No. 1 in the stagger diagram of Fig. 2 is Q = 18.6/1.6 = 11.6. In the examples given above the total tuning capacitances have been assumed

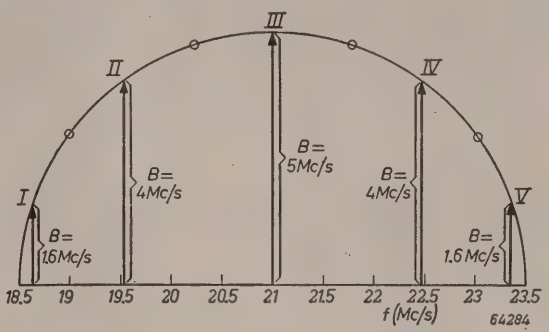


Fig. 3.—Stagger diagram for a three-stage I.F. amplifier centred at 21 mc/sec.

to be 22 pF, which is about twice the sum of the input and output capacitances of the tube. The total parallel resistance of this circuit is now:

$$R = \frac{Q}{2\pi f_o C} = \frac{11.6}{2\pi \times 18.6 \times 10^6 \times 2.2 \times 10^{-11}} = 4500\Omega.$$

Assuming the actual coil Q to be 25, this being a value which can easily be reached in practice, the parallel resistance of the circuit would be 25/11.6 × 4500 = 9700 Ω. In order to arrive at the required total parallel resistance of 4500 Ω a grid leak of 8400 Ω should be

VACANCY FOR PATENT EXAMINER (ELECTRONICS)

There is a vacancy for a Patent Examiner (Electronics) in the Patents, Trade-marks, and Copyright Division of the Justice Department, Wellington. Salary up to £710 a year, according to qualifications and experience. The position offers interesting work on the very latest developments in this field, and more particularly Radio and Television Engineering. Appointee will be required to examine patent applications for novelty and patentability, and should be competent to write short abridgments thereof for publication. Whilst professional academic qualifications are preferred, applicants without them who are sufficiently competent in this field will also be considered.

Applications should be made on P.S.C. Form 17A, obtainable from all Post Offices, with *copies only* of testimonials, and forwarded direct to the Secretary, Public Service Commission, Wellington, C.1.

chosen in this case. The grid leaks of the other stages can now be calculated in a similar way.

Referring once more to Fig. 2, it will be clear that in the case of large numbers of mutually detuned circuits the bandwidths of the outermost circuits in the stagger diagram may become inconveniently small. This difficulty can be avoided by using two or more identical staggered groups in cascade, but this involves some loss of total gain. According to this method a five-stage amplifier, thus with six tuned circuits can be composed of two identical groups of three circuits or of three groups of two circuits. If, however, the 3 db. bandwidth of each group is again chosen equal to the required total bandwidth of the amplifier, the drop of the limits of the total pass band will be 6 db when two identical groups are employed and 9 db in the case of three groups in cascade. It is therefore necessary to give each group a bandwidth greater than the total bandwidth of the amplifier. The factors with which the required total bandwidth of the whole amplifier must be multiplied to obtain the bandwidth of each group can be found in the following table:

Number of staggered circuits in each group	Number of identical groups 1	2	3	4	5
1	1	1.56	1.96	2.27	2.56
2	1	1.25	1.41	1.54	1.61
3	1	1.16	1.25	1.32	1.37
4	1	1.11	1.19	1.23	
5	1	1.09	1.15		
6	1	1.075	1.11		
7	1	1.05			

From this table it appears that the required bandwidth of each group increases with the number of groups employed. In an amplifier with six tuned circuits, for example, the factor is 1 in the case of one staggered group, 1.16 for two identical groups of three circuits and 1.41 for three groups of two staggered circuits. In the latter case when the total bandwidth of the amplifier has to be 5 mc/sec. each group must have a bandwidth of 7 mc/sec. and, since the product of gain and bandwidth is constant for a given type of tube, the result will be a smaller gain.

It is interesting to note the difference in performance with regard to gain between an amplifier employing circuits all tuned to the same frequency and a stagger-tuned amplifier. The four-stage stagger-tuned amplifier of Fig. 1 gives a gain of 10,000. In another four-stage amplifier, however, in which the five circuits are all tuned to the same frequency, the bandwidth of each individual circuit would have to be 2.56 times the required total bandwidth. Whilst the stage gain of the stagger-tuned amplifier was 10, in the latter case this would be reduced to about 4, giving a total gain of $4^4 = 256$.

The inclusion of traps for the suppression of the sound carrier and for adjacent sound and picture signals will influence the shape of the response curve of the I.F. amplifier. This will usually necessitate small corrections of the tuning frequencies and dampings of the I.F. circuits when these are determined according to the method represented in Figs. 2 and 3. Also the sequence of the circuits will often be chosen differently, for various reasons, although this does not influence the shape of the response curve. The first stages of the picture I.F. amplifier are normally also used to amplify the I.F. sound signal, which is usually tapped off after the second I.F. stage. Economies may then be effected in the design of the sound I.F. amplifier by choosing the most favourable stagger frequencies with regard to sound I.F. amplification for the first stages of the picture I.F. amplifier. This, however, often conflicts with the requirements of picture contrast control and a compromise must then be sought. The contrast of the television picture is normally adjusted by varying the bias of the tubes in the first stages of the receiver. Owing to unavoidable oscillator-frequency shift the bias of the mixer stage may not be varied and contrast control must therefore be achieved by varying the bias of the R.F. stage and of the first two I.F. stages. Variation of the bias, however, results in a variation ΔC_i in the input capacitances of the tubes and this may upset the total response curve of the receiver. Therefore, those I.F. circuits from the stagger diagram having the largest bandwidths should be used to precede those tubes of

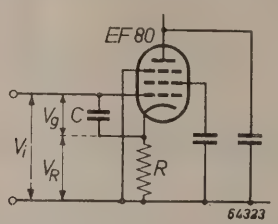


Fig. 4.—Basic circuit for the compensation of input capacitance variation.

which the grid bias is varied, as this keeps the influence of the contrast control upon the total response curve as small as possible. As may be seen from the curves in the data section, when the slope of the tube is varied between 7.4 and 0.74 mA/V, the variation in input capacitance of the EF80 is 1.95 pF. This variation may be inadmissible and special methods are available to reduce this variation. A simple and efficient form of ΔC_i compensation will now be briefly described.

Compensation of input capacitance and resistance variation

To give a complete explanation of this method it would be necessary to consider many effects, including those of lead inductances, stray capacitances and transit time. The practical value of such an analysis however is limited, as lead inductances and stray capacitances occurring in production cannot be accurately predicted. The most favourable values of the components for compensating the variation in input capacitance and resistance are therefore normally determined by experiment, but the main principles should, of course, be understood.

In the basic circuit of Fig. 4 a non-bypassed resistor is included in the cathode lead, C representing the capacitance between grid and cathode of the tube. Due to electronic effects this capacitance varies with the bias. In the cut-off condition C has a value of 7.2 pF, this gradually increasing to about 9.4 pF when the grid bias is reduced to —2v. In the first case the effective capacitance measured across the input terminals is practically

(Continued on Page 33.)

- LOW INERTIA ALUMINIUM SPOOLS
- LOW FRICTION—LONG LIFE
- HIGH OUTPUT—MINIMUM BACKGROUND
- INTERCHANGES with OTHER TAPES
- AVAILABLE IN 600, 1200, 2400, and 3250 ft. SPOOLS
- LOW COST

in a RECORDING TAPE for every purpose—the

NOW-famous

EMITAPE

recording tape—

Magnetic Recording Tapes to the Highest Professional Standards

Now the well-known EMITAPE is available in magnetic recording tape for commercial and domestic Recorders. For superior performance on any Tape Recorder, use EMITAPE.

EMITAPE is made with Plastic base in the spool sizes 600 ft., 1200 ft., 2,400 ft., and 3,250 ft. The Plastic base is tough, with a high breaking strength, and has a specially smooth finish for uniform coating.

EMITAPE HIGH COERCIVITY QUALITY NOW AVAILABLE

H·M·V

"HIS MASTERS VOICE"

262-272 WAKEFIELD STREET, WELLINGTON P.O. BOX 296 PHONE 45-015 (5 lines)

TRANSFORMER Co. OF NEW ZEALAND Ltd.

•

ADVISES

Complete working operations now being carried on at their NEW PREMISES

78 NELSON STREET
PETONE

Phone 61-498 **Telegraph: DACO** **Box 175, Lower Hutt**

Only three minutes from Petone Post Office

Complete facilities for the design, manufacture, and testing of all types of power and audio transformers—battery chargers, emergency lighting plants, selenium rectifiers and their associated equipment also catered for as well as all types of Electronic apparatus.

Let us have your inquiries—We are set up to handle large or small orders.

Introduction to Radar Techniques

Part IV.—The Radar Receiver

By the Engineering Department, Aerovox Corporation

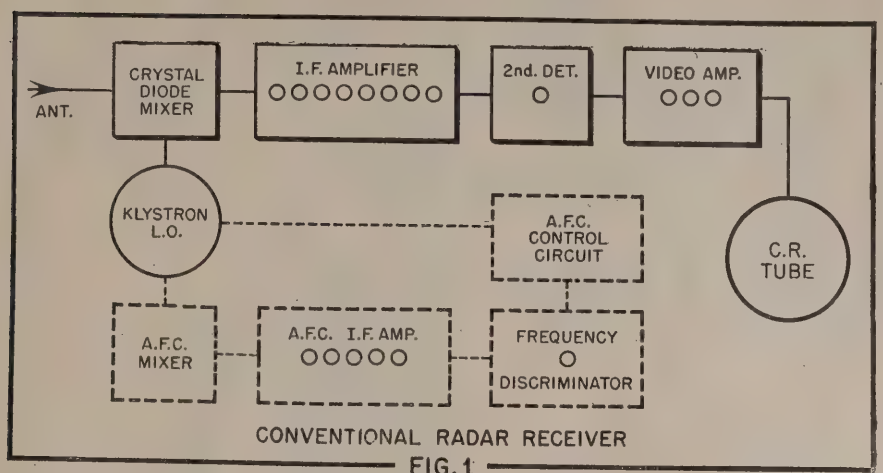


FIG. 1

This is the fourth in the series of articles dealing with the special components of the microwave radar equipment. It consists of a discussion of the receiving portion of the generalized radar set—especially the microwave parts such as the crystal mixer and the klystron local oscillator. The other components are covered in less detail since they have been discussed here previously or are standard practices in fields other than radar.

The function of the radar receiver is to detect the very weak echo signals returned by the target and to greatly amplify them so that they can be visibly displayed on the screen of an oscilloscope to convey information regarding the range and azimuth of the target. As was indicated by the "radar equation" given in Part I, the range of a radar system is inversely proportional to the *fourth root* of the minimum signal which the signal will detect. The minimum detectable signal is determined by the noise figure of the receiver, so that any improvement in the receiver noise characteristics result in improved range. Since a three decibel improvement in the receiver sensitivity would have the same effect on set performance as doubling the transmitter power, and at considerably less expense and power consumption, much effort has been expended toward this end. It is probable that added range can be obtained more economically by receiver improvements than elsewhere in the radar system, with the possible exception of the antenna. And, since typical radar receivers exhibit noise figures about 13 to 50 times greater than that of a theoretically perfect receiver, there is still sufficient room for improvement.

For reasons of greater sensitivity and selectivity, the superheterodyne type of receiver is almost universally used in modern radar practice. A block diagram of its component parts is given in Fig. 1. The input stage is usually the mixer, or frequency converter, in which the echo signal from the target is heterodyned with the local oscillator signal to produce a difference frequency which is amplified by the I.F. amplifier. The output of the I.F. amplifier is rectified by a second detector and fed into a video amplifier and thence to the cathode-ray viewing tube.

THE CRYSTAL MIXER

For microwave radar, the mixer is usually a silicon crystal diode. An R.F. amplifier is seldom employed since microwave amplifier tubes having sufficiently low noise figures do not exist in practical form at present. The crystal mixer, on the other hand, has good noise and transit time characteristics and permits the signal to be converted immediately to a lower frequency where the state of the art affords low-noise amplification. The most serious disadvantage in the use of the crystal mixer lies in its susceptability to accidental burn-out by the high power transmitter pulses. It is the function of the "duplexing system", to be described in the next issue of this series, to protect the crystal from such burn-out while the transmitter is operating.

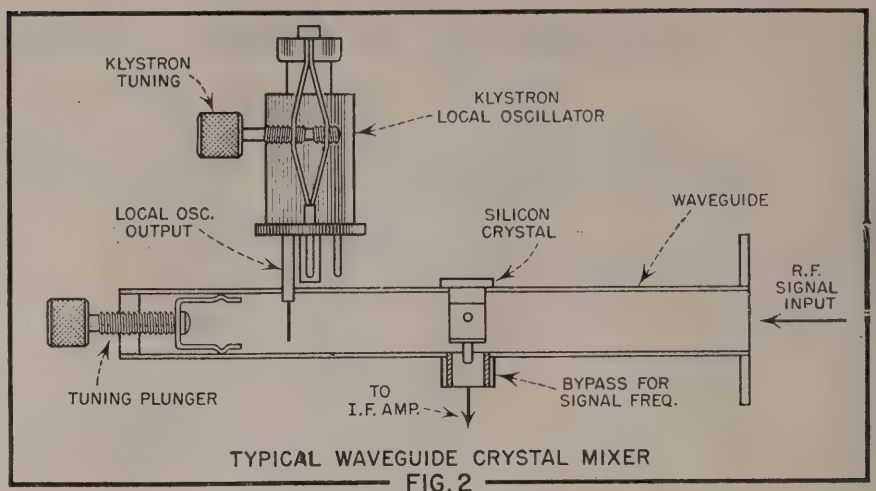
The details of a typical crystal mixer are shown in Fig. 2. The silicon semi-conductor diode is mounted in a socket across the waveguide into which is coupled the R.F. signal and the local oscillator signal. The amount of local oscillator injection is regulated by a tuning element such as tuning screws or a plunger. The I.F. difference signal is taken out at one end of the crystal by a coaxial coupler which is by-passed for the signal frequency but not for the lower I.F. frequency. The *conversion loss* of the crystal mixer circuit may be as much as 10 db. This loss is easily made up in the I.F. amplifier stages, however.

THE LOCAL OSCILLATOR

The local oscillator, or "beating oscillator" as it is sometimes called, must be a stable, continuous-wave signal source which will tune over the range of frequencies covered by the radar set. It is usually the only vacuum tube in the receiver which operates at a microwave frequency. Although triode oscillators of the "lighthouse" type have been used in some cases up to about 3000 megacycles, the klystron or *velocity modulation* tube is more universally employed.

The klystron oscillator is a special form of microwave vacuum tube which, like the magnetron, was developed largely during World War II for use in radar. The kind most commonly used for receiver local oscillators is the reflex klystron illustrated in Fig. 3. In this tube a thin beam of electrons, like that in a cathode-ray tube, is projected from an electron gun through two apertures in a cavity resonator. If oscillations are assumed to exist within this resonant circuit and the R.F. electric field associated with this oscillation is con-

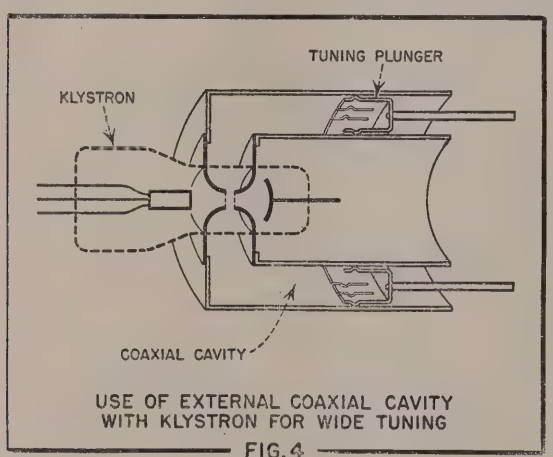
centrated between the apertures, some of the electrons passing through the cavity will be slowed down while others will be accelerated. This process is known as *velocity modulation.* It occurs because some of the electrons traverse the cap while the R.F. field adds to the D.C. accelerating potential applied between the cathode and the cavity, while others cross while the R.F. field is retarding. The net result of this is that the slow electrons are overtaken by the fast ones at some finite distance beyond the cavity, so that dense packets or "bunches" are formed.



TYPICAL WAVEGUIDE CRYSTAL MIXER

FIG. 2

In the reflex klystron, a *reflector,* or *repeller,* electrode is used to turn the bunched electron beam around and send it back through the cavity. By adjusting the negative D.C. potential on this reflector, the distance between the cavity and the reflector may be controlled so that the dense bunches of electrons form just as they are traversing the gap in the R.F. cavity for the second time. If these bunches of electrons, which are spaced the period of one R.F. cycle apart, are timed to cross the gap while the R.F. field there is retarding, they will

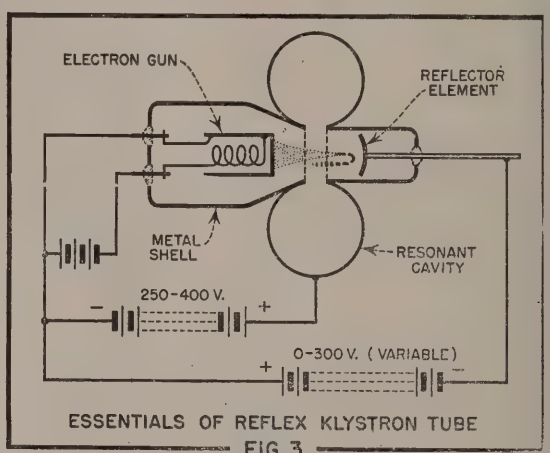


USE OF EXTERNAL COAXIAL CAVITY WITH KLYSTRON FOR WIDE TUNING

FIG. 4

be slowed down and some of their kinetic energy will be converted into R.F. energy to reinforce the oscillation. As in the magnetron, or any other oscillator, the original oscillation may be initiated by a noise voltage or other random fluctuation.

The reflex klystron is characterized by relatively low efficiency ($\frac{1}{2}$ to about 2 per cent.) but ease of tuning and simplicity. Although only a few milliwatts of power must be supplied to the crystal mixer for efficient conversion, most klystron oscillators are designed to deliver many times that much so that the oscillator may be loosely coupled to the mixer. This is done to improve the operating stability of the oscillator. Also in connection with frequency stability, the D.C. voltages applied



ESSENTIALS OF REFLEX KLYSTRON TUBE

FIG. 3

to the cavity and repeller of a reflex klystron as shown in Fig. 3 must be well regulated. An electronically regulated power supply is usually employed, although in some cases simple VR tube regulation will suffice.

Mechanical tuning is usually accomplished in the reflex velocity modulation tubes by deforming one or both walls of the cavity resonator in a manner such that the gap spacing, and hence the capacity of the resonant circuit, is varied. In other types, the resonant cavity is not an integral part of the klystron tube but is clamped around it so as to make good electrical contact to disc seals which connect to the internal gap. Tubes of the "external cavity" type are usually tunable over greater frequency ranges than "integral cavity" tubes, especially when the external tuner is a coaxial type like that illustrated in Fig. 4. Tubes exist which will tune over a 2 : 1 range of frequencies in a circuit of this type in contrast with a maximum of about 20 per cent. tuning for the integral cavity types. To maintain oscillation, the reflector voltage must be changed with the tuning on all reflex klystron types.

Another feature of velocity modulation reflex tubes which is important in radar applications is *electronic* tuning. The operating frequency of most reflex kly-

Osram

VALVES

A tonic to any set

BRITISH GENERAL ELECTRIC CO. LTD.

Wellington, • Auckland, • Christchurch, • Dunedin.

strons may be varied as much as 1 per cent. by changing the repeller voltage slightly about the value which gives maximum power output. The electronic tuning and power output characteristics of a typical 10,000 megacycle reflex klystron, plotted versus repeller voltage, are shown in Fig. 5. Note that the tube oscillates at several discrete values of repeller voltage. These are called "repeller modes." They correspond to different repeller voltages at which the electrons are reflected into the cavity in the right phase to sustain oscillations. The average velocity electron may take $\frac{3}{4}$, $1\frac{3}{4}$, $2\frac{3}{4}$, or $3\frac{3}{4}$ R.F. cycles in the "drift space" between the cavity and reflector, and still return in the right phase.

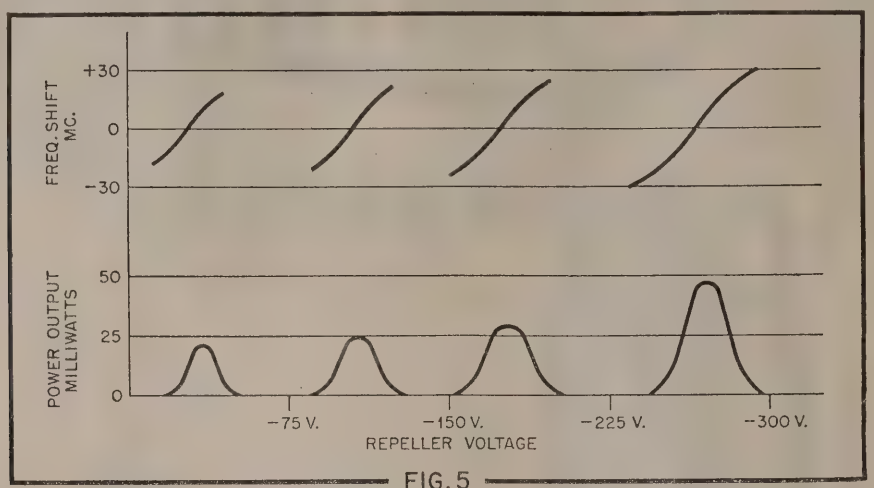


FIG. 5

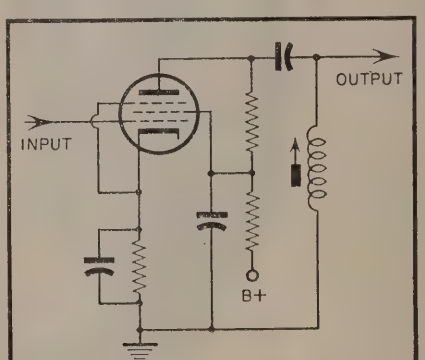
Electronic tuning by varying the repeller voltage is important for radar receivers since it allows the use of a system of *automatic frequency control* to keep the receiver tuned to the frequency of the transmitter in spite of variations due to thermal drift or load impedance changes. The parts of a representative AFC circuit are shown as dotted lines in Fig. 1. It consists of an extra crystal mixer and I.F. strip which sample the transmitted signal and apply it to a frequency discriminator. If the transmitter frequency varies the discriminator develops an error voltage which is applied through appropriate control circuitry to the repeller of the klystron. The local oscillator is thus automatically retuned to the transmitter frequency as long as it remains within the klystron's range of electronic tuning.

THE I.F. AND VIDEO STAGES

The remaining circuits of the radar receiver, that is, the I.F. and video amplifiers and the second detector, are quite similar to those encountered in television practice.

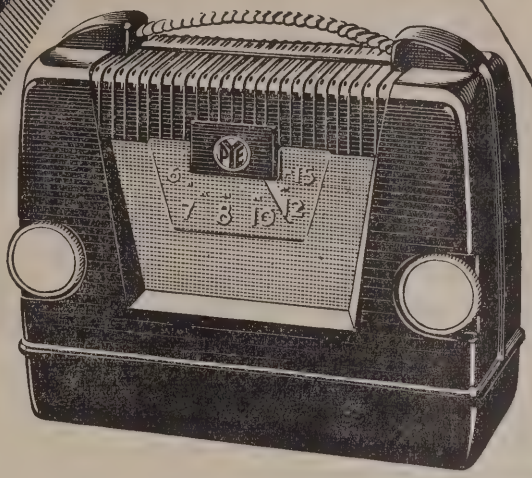
Most of the gain of a typical radar receiver, which is usually about 120 db., is obtained from the I.F. amplifier, which may consist of as many as ten stages. The selectivity of the receiver is also determined by the bandpass of the I.F. amplifier. Since the spectrum width of the transmitted signal is considerable for the transmission of very short pulses, the I.F. band-width must usually be several megacycles. A figure sometimes used by system designers for receiver band-width is 1.6/t, where t is the transmitter pulse duration in microseconds. To obtain such bandwidths, double-tuned or stagger-tuned I.F. stages are employed. A typical single-tuned radar I.F. amplifier stage is shown in Fig. 6. Such stages depend upon high gm tubes like the 6AK5 or the 6AC7 for high gain-bandwidth products. The resemblance to conventional television I.F. stages (minus the sound traps) is evident.

Since the crystal detector contributes no gain, the noise characteristics of the first I.F. stage are very important in determining the overall noise figure of the receiver. For this reason, much work has been devoted to the development of low-noise I.F. input stages. Special low-noise triode circuits such as the *cascode* amplifier are widely used in radar practice.



TYPICAL SINGLE-TUNED RADAR I.F. AMPLIFIER STAGE
FIG. 6

RADIO CLASSSES
For Operators, Engineers, Servicemen, commence on 2nd February, 1953. Enrolments received now.
NEW ZEALAND RADIO COLLEGE
26 HELLABY'S BUILDING - AUCKLAND, C.1



Always ready to entertain

Pye Model Q, the Handy Portable, brings you first-class listening *wherever* you are. Compact, easy to carry, it can be operated anywhere from A.C./D.C. Mains or from its own batteries. Model Q provides a wide choice of programmes with remarkable tone and power. Here is the perfect companion for home, holiday, or travel — the set in fact for YOU ! Ask your Pye Agent for a demonstration.

5-valve, plus rectifier, portable for operation from either A.C., D.C., or batteries.

PRICE £27-10-0

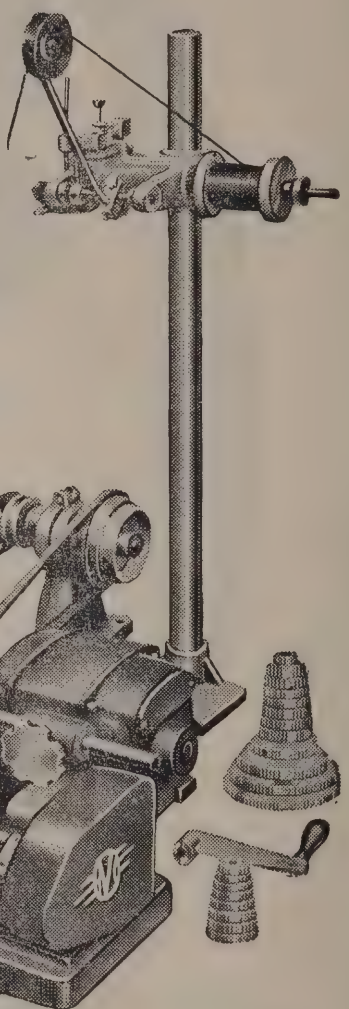
PYE Radio and Television

Look for the distinctive PYE trademark at better radio dealers everywhere or for your nearest Pye Agent write to: PYE (New Zealand) Limited, P.O. Box 2839, Auckland.

P34

To Radio Manufacturers and Coil Winders

—A NEW AND IMPROVED WAVE-WINDING MACHINE



DESCRIPTION OF MACHINE

The "DOUGLAS" Progressive Wave-Winding Machine has been developed to meet the demand by coil manufacturers for a machine which will provide efficient progressive wave-wound coils giving the designer a very great latitude in the spacing and sizes of coils which can be handled. Not only does the machine wind the progressive type of coil, but also the conventional wave-wound coils in pie form with practically the same range as the well-known "DOUGLAS" Wave Winder

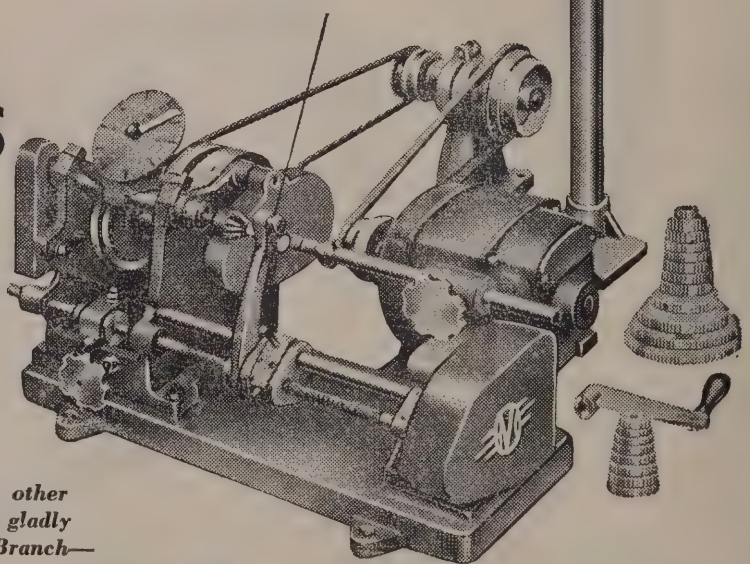
The

DOUGLAS

Progressive

WAVE WINDER

(Power Driven)



Full details of this and other "DOUGLAS" Winders will gladly be supplied. Write any Branch—

THE **NATIONAL** NEECO **ELECTRICAL**

AND ENGINEERING COMPANY LIMITED

AUCKLAND WELLINGTON CHRISTCHURCH DUNEDIN HAMILTON
WANGANUI HASTINGS INVERCARGILL

Sole New Zealand Distributors for the Automatic Coil Winder and Electrical Equipment Co., Ltd., London

SHOES and SHIPS

"The time has come," the Walrus said
"To talk of many things. . . . "

By Special Arrangement with the Walrus

SPEECH REPRODUCTION

In this age of enlightenment, sound reinforcement has become the accepted and expected thing where public speaking is practised to any extent. Places coming into this category are swimming baths, sports arenas, the many agricultural showgrounds and then a host of others such as hotel paging systems, intercom. units, and the like. The public are becoming aware of the usefulness of audio equipment for these purposes, which interest is reflected in the amount of business conducted in this field by radio businesses throughout the country.

Now where the effective reproduction of speech alone is concerned, much can be done to improve the characteristics of amplifiers intended for this work. For the highest possible fidelity where a variety of speakers will be using the equipment, it appears that speech will require a bandwidth approximating that required for wide-range music reproduction. However, where the conveying of intelligence is concerned, a considerably reduced bandwidth can be employed to advanatge. A frequency range of 200 to 3,500 cycles will prove adequate and while certain voices may tend to lose their individual identity, the clarity and intelligibility of the speech will be completely satisfactory. After all, nobody finds much fault with the normal telephone services sound quality for speech work, and the pass band employed there is quite narrow.

The advantages to be gained by restricting the bandwidth are to bring about a definite reduction in unwanted noise, both locally generated in the amplifier and also picked up by the microphone. Into this class comes low frequency filter hum and high frequency valve hiss, both of which can be substantially reduced. Perhaps the greatest advantage that can be obtained, however, is by emphasizing the higher frequencies within the bandwidth to be used. Most radio men will appreciate that maximum power requirements from an amplifier generally occur at the low frequency end of the scale, if then in a system intended for speech, a rising characteristic of 6 db. per octave be provided in the amplifier, a definite gain in loudness efficiency will be obtained. This frequency emphasis characteristic should be performed ahead of the output stage so that the grid swing which it accommodates is correspondingly reduced. This can either make more power available before overload occurs or otherwise bring about economies in the construction of the amplifier—notably in the output transformer. The overall effect will be to impart a sharp incisiveness to the speech which is excellent for commanding attention and for penetrating through noisy areas.

The next question must then be how can this desirable state of affairs be brought to pass? There are several ways, one of the most simple and yet effective is in the correct choice of a microphone. There are on the market at present, crystal microphones having peaked response curves eminently suitable for this type of work. They are tailored to give a rising response of varying amplitudes within the speech range depending on the individual customer's requirements.

Another method which has much to commend it is in the use of an appropriate corrective filter network within the amplifier itself. Any of the many published bass and treble cut-and-boost circuits can be employed with the controls tucked away out of sight so that they are accessible only to the serviceman. Adjustments can then be made on the spot where the equipment is to be operated so that best results are obtained and the controls locked in that position. This system has the advantage of reducing noise generated within the early high-gain stages of the amplifier.

Another, and rather spectacular method, is in the use of the new re-entrant type pressure speakers. These generally have a restricted frequency range, ideally suited for speech, and an efficiency considerably in excess of ordinary cone speakers. Their sound output is directional and can, therefore, be beamed in the most desirable direction. For outdoor work they are definitely to be preferred to other forms of speakers.

For house intercom. systems, where economical construction is a big factor, simple frequency correction can be brought about by reducing the coupling condensers between stages to a fairly low value (0.005 μf. or less) and by incorporating an output transformer of small enough proportions to ensure that bass response is well down. Both of these methods bring about a response rising with frequency in an entirely satisfactory manner.

It can be seen then that while an ordinary amplifier will give results, by a little careful study of the individual application, a much more effective job can be done.

CASTELCO PRODUCTS

New Zealand Distributors:
E.M.I. SUPPLIERS
162-172 Wakefield Street - - Wellington

FOR SALE

5 ZC1 Sets with numerous small parts.
One complete 50w. Shortwave Transmitter.
One mobile 10w. Shortwave Transmitter.

The price for all the above is £150 or near offer, but the sets may be purchased singly if desired.

All the above may be seen at

M. STEVENSON LIMITED
Cnr. FISH and WILLIS STREETS, DUNEDIN
Phone 11-769 Postal Address: P.O. Box 836, Dunedin

The PHILIPS Experimenter

An advertisement of Philips Electrical Industries of N.Z., Ltd.

No. 62: The Use of "Ferroxcube" in Radio and Allied Equipment

Reprints of these EXPERIMENTER articles, complete with illustrations, will be mailed to any address for one year for a subscription rate of 5s. Application should be made to Technical Publications Department, Philips Electrical Industries of N.Z., Ltd., P.O. Box 2097, Wellington.

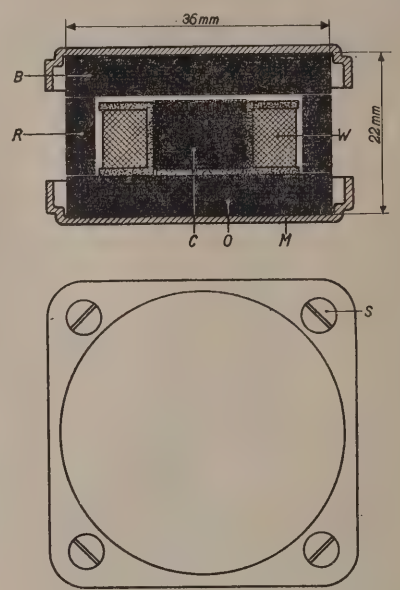
Already in the pages of the Experimenter, mention has been made of Ferroxcube, and of some of the components which usé it. This new magnetic material has physical properties which are quite different from those of all others which have previously been used for the construction of high-quality circuits at frequencies ranging from audio to video and even higher. It was developed in the Philips laboratories at Eindhoven, more especially, in the first instance, with certain applications in connection with carrier telephony in view, but since then, numerous grades and types of Ferroxcube has been perfected, each with its own particular range of frequencies, and therefore of applications to which it is best suited. As a result, the number of applications which have been found for Ferroxcube has multiplied enormously, and is still growing. Today, this revolutionary material finds use in a very wide range of electronic equipment, from telephony and audio frequency equipment to components for television receivers, broadcast and all-wave receivers, and the applications of supersonics. Indeed, Ferroxcube is assuming such importance that it was felt that all those who read the Philips Experimenter would gain something of value from an article devoted to its properties and uses.

WHAT IS FERROXCUBE?

Ferroxcube is a ceramic material consisting chemically of certain ferrites. These are chemical compounds, of one of the oxides of iron with other metallic oxides, and contain no uncombined, or free iron, whatever. For example, one type of Ferroxcube, Ferroxcube III, consists of crystals of manganese-zinc ferrite, while Ferroxcube IV, which has somewhat different magnetic properties, is nickel-zinc ferrite. Magnetic materials containing no free iron or other ferro-magnetic metal are not new. Indeed, the oldest known magnetic material, lodestone, was known to the ancients, and consists basically of tri-ferric tetroxide, Fe_3O_4. However, it is only with the development of the Ferroxcubes that non-metallic magnetic materials of practical utility in alternating current circuitry have been available to engineers.

WHAT ARE ITS MAIN ADVANTAGES?

For many years now there has been a great need for low-loss inductors which would retain their low loss characteristics at high audio frequencies and beyond. Carrier-current telephony, which uses carriers running well into the hundreds of kilocycles per second, must employ highly discriminating band-pass filters in order that these carriers may be separated from each other with great precision, and with the lowest possible losses in their pass-bands. These filters are complex structures of chokes and condensers, and must satisfy a number of stringent requirements. For example, if the losses in the chokes are not small, the filters do not cut off sharply enough, which means that valuable space in the spectrum must be wasted in order that the adjacent carriers in the system, together with their speech side-



Construction of a coil using a small Ferroxcube pot-type core. W = coil; O = bottom plate to which centre portion of core can be cemented. R = annular core section. C, B, R, and O are of Ferroxcube. M = brass plates which, with bolts S clamp the assembly together.

bands, shall not cause mutual interference. Similarly, high losses in the chokes of the filters mean considerable losses in the pass bands of the filters, thus necessitating more amplifier stages, and making it more difficult generally to realize the required performance from the whole system. Now the manufacture of low-loss chokes and transformers for the range 20 to 500 kc/sec. is dependent upon the magnetic materials that are available from which to make the cores. It is possible to dispense altogether with cores, and use air-wound inductors, but if this is done, the shielding required and the size of the inductors themselves would make the bulk of the whole complex equipment quite prohibitive. For these frequencies, too, solid cores, such as are used at lower frequencies, cannot be used at all, because the core losses are too high for the required inductor characteristics to be obtained. Accordingly, it has been the practice to use the magnetic material in powdered form,

held together by plasticizing and binding agents. This dust-type core material is successful in reducing the iron losses, because it represents the ultimate in lamination, which at lower frequencies is used for the very same reason—namely in order to reduce the eddy-current losses in the core. Unfortunately, these dust cores are not as effective magnetically as they might otherwise be, simply because of the small amount of magnetic material per unit volume of core material. In other words, the effective permeability is low, which necessitates a greater number of turns on a given coil to give it a particular value of inductance.

The great advantage of Ferroxcube over dust cores, is that its permeability is much higher, and yet its eddy-current losses are smaller still than those of the dust core. As a result of this, it is possible to make coils of a given inductance smaller, and with a higher Q than has hitherto been possible with any core material that has been devised. When it is realized that a single carrier-telephony terminal equipment has hundreds of high-frequency high-Q inductors in its design, the importance of a new material such as Ferroxcube can hardly be over-estimated.

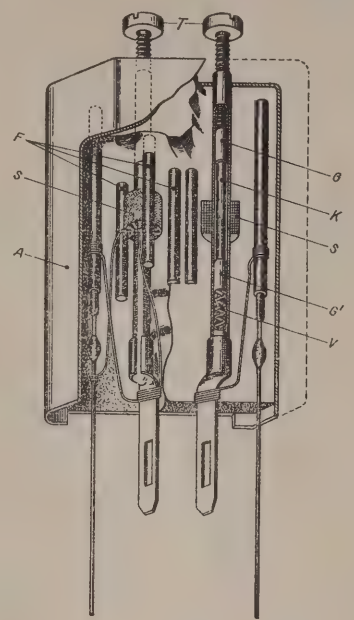
As a practical example of what can be achieved in this manner, it is instructive to note the case of a particular coil, as used in a telephony filter circuit. The coil of the older type was one wound on a toroidal dust-core. It had a volume (inclusive of the necessary screening can) of 220 cubic centimetres, and had a Q of 220 at 60 kc/sec. The Ferroxcube equivalent, wound on a small pot-type core has a volume of only 44 c.c., and a Q of 600 at 60 kc/sec.

VARIOUS APPLICATIONS OF FERROXCUBE CORES

In the space of a short article like the present one, it is impossible to give even a small fraction of the comprehensive technical data that has been issued by the Philips laboratories on Ferroxcube. It is a rather unfortunate fact, too, that many of the technical questions that are likely to be asked by intending users cannot be answered directly or in any simple and universally applicable manner. For instance, where the windings must carry high currents, it is not possible to specify the maximum number of ampere turns that can be used on a given core, since the allowable maximum flux density will vary considerably according to the application. For example, the larger types of pot core have been successfully used as the inductive elements of loudspeaker dividing networks, but without experiment, it is not possible to say what audio power these cores can handle without introducing distortion at low frequencies. Indeed, the greater number of applications of the material that are at this stage quite well understood from all practical and theoretical angles are those in which only low flux densities are concerned. This is largely because it is known that the saturation flux densities of the Ferroxcubes are known to be considerably lower than those of other magnetic materials.

USE OF FERROXCUBE IN RADIO

One of the most spectacular applications of the material is to the manufacture of I.F. transformers, where, again owing to its high permeability and low loss, Ferroxcube is decidedly superior to dust core materials. It has enabled very minute I.F. transformers to be made, with higher-Q windings than many makers have succeeded in achieving even in units many times their size. The illustration of Fig. 1 shows the construction of one of these midget transformers. The very small universal wound coils are on small tubular formers inside which a rod of Ferroxcube, about the thickness of a pencil lead slides in order to vary the inductance of the coil, for tuning purposes. Each coil is surrounded by three



..I.F. transformer employing Ferroxcube. S = coils; K = Ferroxcube cores, adjustable by means of screws T and glass rods G. Ferroxcube rods F constitute a screen for reducing losses in the aluminium can A. The components on the extreme left and right are "drawn" wire condensers.

vertical rods of Ferroxcube, the purpose of which is to absorb the majority of the lines of force external to the coil, preventing them from linking with the aluminium of the shield can. In addition to improving the shielding of the transformers, these rods materially reduce the losses due to the proximity of the can, thereby enabling the Q of the coils to be kept much higher than it could be otherwise, so closely spaced from the shield can. Transformers of this construction, designed for use in the vicinity of 455 kc/sec., have winding Qs of as high as 174.

Small two-piece pot cores are available from which high-quality coils can be made for broadcast band frequencies. These pots are approximately $\frac{1}{2}$ in. in diameter and $\frac{1}{4}$ in. deep, and as with other Ferroxcube pots, are self-shielding, since the winding is totally enclosed by the core material. To give some idea of the inductance that can be obtained with these minute cores, it was found that when the small bobbin was wound with 160 turns, the resulting coil resonated at 100 kc/sec. with a shunt tuning capacity of only 100 $\mu\mu$f., indicating an inductance of approximately 25.4 millihenries. From this, it can be computed that for a coil of 175 h., which is the inductance required to tune to 570 kc/sec. with a total capacity of 450 $\mu\mu$f., only about 13 turns would be required!

(Continued on next page.)

USE IN TELEVISION

Ferroxcube is finding considerable use in the design of special components for television receivers. It is used as the core material for deflecting-coil assemblies, and for line output transformers, which also supply the E.H.T. voltage by the pulse method. In projection TV receivers, it is used for the pulse transformers which enable the very high voltages of 25 kv. and upwards to be generated. In television transmitting circuits, and similarly in radar transmitters and receivers, it is used for blocking oscillator transformers and pulse transformers.

Another new and striking use for Ferroxcube is in making directional aerials for portable receivers. If a long rod of high-permeability material is wound at the centre with a few turns of wire, it acts in such a way as to concentrate through the rod any magnetic field in which it is placed. It has been found that a Ferroxcube rod approximately 8 in. long, and $\frac{3}{8}$ in. in diameter, wound with a suitable coil, can be used as the first tuned circuit in a broadcast receiver, and at the same time as an aerial, just as is a frame aerial in conventional portables. Such a rod, with its coil, has been found equivalent to a loop aerial approximately 9 in. x 5 in. in size., as far as pick-up is concerned, and of at least as good Q as the conventional loop. Such an aerial would be very easy to mount in the cabinet of a portable receiver, and would be much less likely to give trouble due to feedback between it and the remainder of the receiver, than the conventional loop.

OTHER USES

Another use of Ferroxcube is to be found in high-frequency induction heating, in which cores of Ferroxcube can be used as a means of shaping the induction field so as to heat certain parts of the work while leaving other parts almost unaffected.

Ferroxcube IV has considerable magnetostrictive properties. It suffers a contraction on magnetization. of from 7 to 22 parts per million in length, and so can be used for magnetostriction filters, in which it has a Q of between 4000 and 5000. It is not suitable as a high-powered transducer, because it is brittle, and liable to fracture if heavily excited at its resonant frequency. The velocity of sound in Ferroxcube is approximately 5500 metres per second, so that a rod a foot long would act as a half-wave resonator at a frequency of about 1400 c/sec.

TYPES AND GRADES OF FERROXCUBE

The two main types of Ferroxcube are Ferroxcube III and Ferroxcube IV. The main difference between them lies in the range of frequencies for which they are suitable. Ferroxcube III may be used up to 500 kc/sec. for high-Q coils, and up to 10 mc/sec. for wide-band untuned transformers. Ferroxcube IV is usable up to about 100 mc/sec. for high-Q circuits.

There are three different grades of Ferroxcube III, namely IIIA, IIIB, and $IIIC_2$, whose main applications are as follows:—

IIIA—developed for low-level carrier telephony transformers, in which high initial permeability is the main requirement.

IIIB—developed for band-pass filter coils of low loss, low temperature coefficient, and high stability.

$IIIC_2$—developed for line output transformers in television apparatus, where relatively high flux density at higher temperatures is required.

IIIB is the grade from which pot cores are made, and is further subdivided into four varieties, as follows:—

$IIIB_1$—for frequencies below 20 kc/sec.

$IIIB_2$—for frequencies between 20 and 150 kc/sec.

$IIIB_3$—for frequencies above 150 kc/sec.

$IIIB_4$—for low frequencies, in cases where extremely low hysteresis losses are required, as in the case of telephone loading coils.

Ferroxcube IV is also divided into grades IVA, IVB, IVC, IVD, and IVE. Of these, IVA is for frequencies up to 500 kc/sec., and somewhat overlaps $IIIB_3$ in application. It is, however, preferred to $IIIB_3$ for fabricating piece parts other than pot cores. The other varieties of Ferroxcube IV are intended mainly for the frequency ranges are follows:—

IVB—for frequencies between 500 kc/sec. and 2 mc/sec.

IVC—for frequencies between 2 and 5 mc/sec.

IVD—for frequences between 5 and 20 mc/sec.

IVE—for frequencies above 20 mc/sec.

The limits quoted in the above paragraphs should not be regarded as rigid, but rather as indications of the best ranges within which to use the various types of Ferroxcube for the production of high-Q circuits.

FOR YOUR SUMMER JOURNEY

Express Trains Offer Roomy Travel-Comfort

When planning your summer travel, remember that trains provide you with very comfortable service at reasonable cost: often the lowest cost.

During the summer holidays, more than 330 extra long-distance trains will serve New Zealand's principal towns and cities. The regular night express trains between Auckland and Wellington will be supplemented at the height of the season by the popular "Daylight Limited." Between Christchurch, Dunedin, and Invercargill, the fast, modern "South Island Limited" resumes its normal thrice-weekly schedule as from December 15.

Most provincial express trains run daily from mid-December to mid-January.

Seats may be reserved two months ahead of travel date.

Book NOW for Holiday Happiness!

The "RADIO and ELECTRONICS" Abstract Service

AERIALS AND TRANSMISSION LINES

A ground plane antenna is a vertical quarter-wave antenna using an artificial metallic ground. For V.H.F. work, however, it is not extensively used as its low driving point impedance is not a good match for the characteristic impedance of standard coaxial cables. The paper describes a method of adjusting the termination as viewed by the transmission line.

—*QST* (U.S.A.), September, 1952, p. 18.

AUDIO EQUIPMENT AND DESIGN

Which tube for audio? With dozens of types in dealers' catalogues the hobbyist planning a new piece of gear has cause for confusion, and asks himself what is new that is good. The answer is that there are no new types that have been proved to make a really significant difference to the home constructor. A summary is given of some old and some new—triodes *v.* pentodes, plate curves, low and high level voltage amplifiers, and some notes on the ample room for experiment.

—*Radio and Television News*, July, 1952, p. 46.

The old standards of record speed, which were fixed of necessity are now being revised, and the long-playing record has been developed, which for a 12 in. size can play for some 22 minutes. The article deals with this type, and a description of some new players developed.

—*Philips Technical Review* (Holland), Vol. 13, No. 5, p. 134.

CIRCUITS AND CIRCUIT ELEMENTS

A new frequency divider. The circuit is based on the balanced modulator divider circuit, but there were difficulties associated with the old type especially in relation to transformer design and these have been overcome, to make a very stable and reliable instrument.

—*Electronic Engineering* (Eng.), September, 1952, p. 413.

ELECTRONIC DEVICES

Electronic Drums—tube-timed drums can develop much higher beat rates, with beats having more abrupt acoustical wavefronts than can be generated conventionally. Two ways of using a solenoid actuated plunger to obtain drum beats have been developed, using thyratrons, and a coder can repeat a volley of drum hits.

—*Electronics* (U.S.A.), August, 1952, p. 98.

The electroencephalograph is a clinical instrument for amplifying and recording the low frequency alternating potentials which appear at points on the surface of the scalp. The scope of the instrument is enlarged by a portable F.M. transmitter carried by the patient when walking or exercising, so that brain waves, heart potentials, and muscle potentials can be recorded by the observer.

—*Electronics* (U.S.A.), August, 1952, p. 126.

Numerous traducers for the electrical measurement of displacement have been described, and the principles employed relate to the movement of a condenser plate, coil, or resistance to produce a variant in the electrical quantity. The device described varies one coil in relation to another, gives a good power output and is very simple and easy to make.

—*Electronic Engineering* (Eng.), September, 1952, p. 420.

INSTRUMENTS AND TEST GEAR

Just because the crystal in your rig is marked with a certain figure, there is no reason to assume that the output is at the same frequency. The device described is a simple absorption meter that can be built into a can with a coil and a variable condenser and a flashlight in series to serve as an indicator.

—*QST* (U.S.A.), September, 1952, p. 16.

There is really no satisfactory substitute for an R.F. output indicator in a transmitter. A crystal voltmeter is an entirely acceptable instrument in place of an R.F. ammeter, and also it allows a great deal more flexibility. A crystal of the general class of the 1N34 may be used. A grounded type of circuit is particularly useful for measuring the voltage into and out of coaxial lines. The voltmeter range can easily be used to fit the voltage level on the line.

—*Ibid*, p. 29.

The article deals with the cost of generating precise radio frequencies. It also describes the results of three types of frequency standards, and gives general details of the construction of a unit capable of holding a frequency to one part in ten million. The crystals, and their accompanying circuits, and means of securing the required accuracy are described in outline.

—*Ibid*, p. 43.

A simple variable frequency phase metering device. The phase shift is measured by adjusting another calibrated network so that its known phase shift equals the unknown shift on the first network, and detection is on the plates of an oscilloscope. A complete circuit diagram of the device is given, with methods of calculation.

—*Electronic Engineering* (Eng.), September, 1952, p. 402.

MATERIALS, VALVES, AND SUBSIDIARY TECHNIQUES

A great deal of experimenting has been done in relation to transistors to improve reproducibility, reliability and designability, and the very small bead head type of junction has been developed. More is now understood about the physics of these devices. The article gives progress made in obtaining improved performance, and considerable improvement in gain is shown with less noise, and vastly improved frequency response.

—*Electronics* (U.S.A.), August, 1952, p. 100.

Attempts are being made to reduce more and more the dimensions of electrical components, and the wire capacitor has very small dimensions and excellent properties. The product is made by a special drawing process and a transformer uses the magnetic material Ferrocube to produce miniature I.F. transformers. A drawing process is also used for indirectly heated cathodes with a conducting core and a tubular emitting surface.

—*Philips Technical Review* (Holland), Vol. 13, No. 6, p. 145.

A study of the characteristics of glow-discharge voltage-regulator tubes. These form a very simple method of voltage stabilization. A survey is made of some of the types obtainable in England, with details of striking voltages, running voltages, etc.

—*Electronic Engineering* (Eng.), September, 1952, p. 396.

Thanks to the development of new materials and methods, the high-pressure mercury lamp with fluorescent bulb has now had an opportunity to take an important place in the field of illumination. The low-pressure mercury lamp was too high in ultra-violet, but this has been corrected, and the discharge takes place in a small tube of fused silica containing a certain amount of mercury and a rare gas, and the lamp may take a conventional form.

—*Philips Technical Review* (Holland), Vol. 13, No. 5, p. 109.

Space charge valves in an accelerated or decelerated electron stream are studied in this paper. The mathematics show that space charge waves on a decelerated stream grow in amplitude, and can thus provide a method for the amplification of microwaves. Three amplifiers of this type have been constructed, and the theoretical gain expression has been verified.

—*Proceedings of the I.R.E.* (U.S.A.), June, 1952, p. 688.

Much progress has been made in relation to industrial magnetrons, and heating at high frequencies can be much faster than at low frequencies. An illustration is given of a 915 mc/sec. magnetron with plate dissipation rating of 3,000 watts—methods of coupling to the load, and various applications.
—*Electronics*, (U.S.A.), August, 1952, p. 104.

MATHEMATICS

The "Smith Chart" gives the impedance at a point on a transmission line when the impedance of the termination is known. In addition, the engineer often wishes to know the phase shift introduction by the section of the line and the magnitude of the voltage and current with respect to the voltage and current at the termination. By extra operations, the Smith chart will give this extra information.
—*Electronics* (U.S.A.), September, 1952, p. 136.

A nomograph is given to aid filter design, for power supplies. The percentage of ripple at the output can be determined for various filters, including choke and capacitor input L.C. filters and R.C. types. The nomograph applies equally to full-wave and half-wave power supplies.

When using the harmonics of the fundamental range of a heterodyne type frequency meter, identification of the number of the harmonic that is beating with the unknown frequency is often puzzling unless the approximate value of the frequency being checked is known beforehand. A little thought shows that there is a simple way of determining the harmonic number provided that the checks are carefully made. A simple graph illustrates the principle.
—*QST* (U.S.A.), September, 1952, p. 24.

A chart is given for resolving complex quantities such as the analysis of transformer iron losses, and the repeated summation of hysteresis and eddy current components of magnetizing currents at different frequencies.
—*Electronic Engineering* (Eng.), September, 1952, p. 426.

A multi-layer coil calculator nomograph for determining multi-layer coil inductance on the basis of the H. A. Wheeler inductance equation. By proper manipulation, the nomograph can assist greatly in designing a coil of a specified inductance.
—*Radio and Television News* (U.S.A.), July, 1952, p. 54.

Universal design curves for tone control circuits. Simple circuit arrangements are described for particular types of tone control, and include frequency-response curves obtainable with each circuit. This can be used by the enthusiast for home-built equipment.
—*Ibid*, p. 32.

RECEIVERS

Super-selectivity with simplified construction and made with surplus components. When endeavouring to extract a weak signal from a mass of stronger ones no degree of filtering at the end of the receiver will do much good. The solution is to reject the unwanted signals before they overdrive any stage. The design given aims to conduct the signals through very narrow filters with the best possible skirt selectivity, and to maintain the signals at a low level until they are operated on by the filters.
—*QST* (U.S.A.), September, 1952, p. 38.

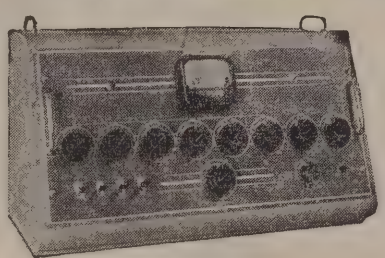
TRANSMITTERS AND TRANSMITTING

A two-band miniature mobile transmitter—10 watts in 120 cubic inches for 3.8 and 7 mc/sec. The design has such attractions as low cost, compactness, simplicity, and low power requirements.
—*Ibid*, p. 11.

A very interesting form of non-synchronous pulse multiplexing is described. The method of "sampling" the signal is used but in this system random samples from each transmitter are tagged for identification at the receiver, which saves the necessity

(Concluded on Page 48.)

INDUSTRIAL COMMUNICATION SYSTEMS

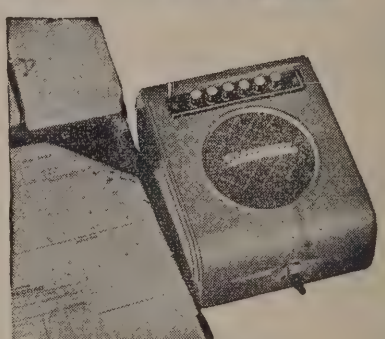


Recording Control Equipment

by

ULTIMATE

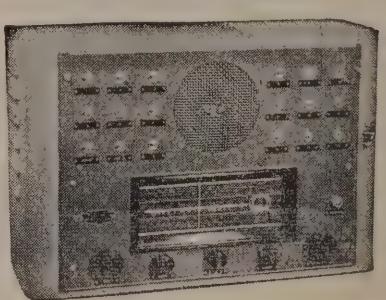
Industrial efficiency depends on speed in communication. Of necessity each installation requires its own design and Ultimate's skilled technicians, with many years of experience, are fully qualified to advise on your particular problem. Write for further information on Ultimate's Communication Specialties.



Executive Intercommunicator

30-Watt Public Address Amplifier

ULTIMATE

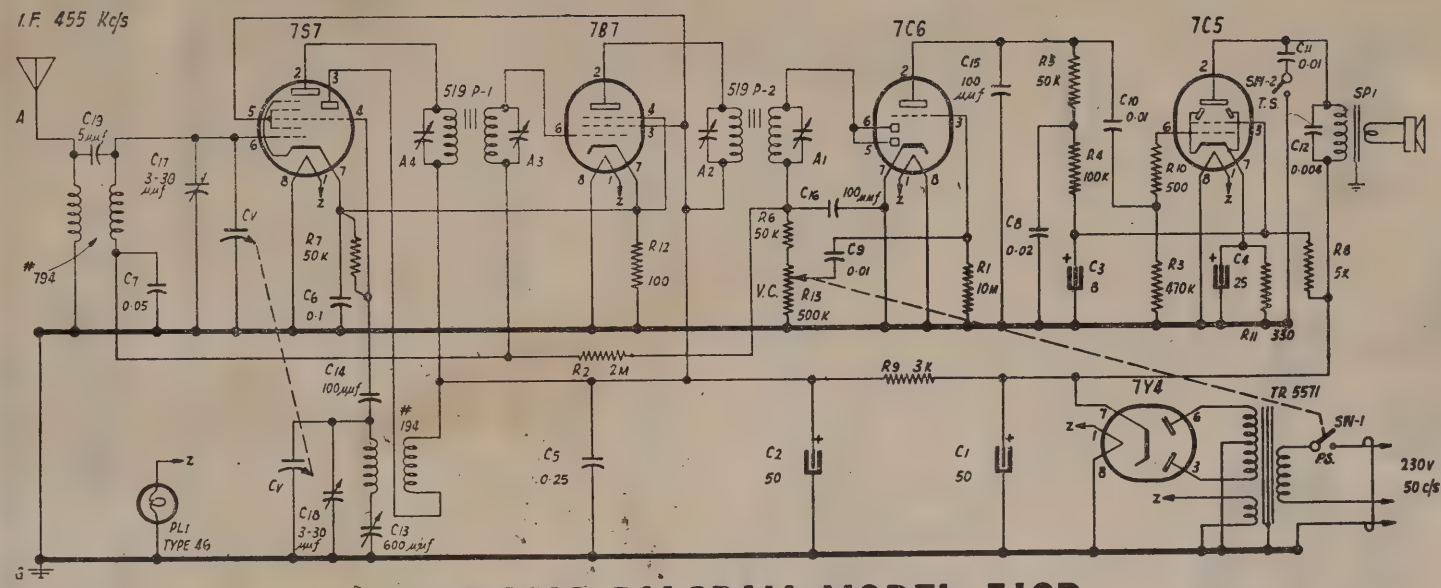


Sound Systems for Schools

Manufactured by **RADIO (1936) LIMITED** QUAY ST. AUCKLAND

CS3.

FOR THE SERVICEMAN: Pacemaker Model 519P



SCHEMATIC DIAGRAM MODEL 519P.

VOLTAGE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
Conv.	7S7	6.3 a.c.	107	107	—5	107	0	2	—
I.F.	7B7	6.3 a.c.	107	107	2	—	0	2	—
Det-AF.	7C6	6.3 a.c.	95	0	—	0	0	—	—
Output	7C5	6.3 a.c.	145	145	—	0	0	7.9	—
Rect.	7Y4	6.3 a.c.	145	155 a.c.	—	—	155 a.c.	150	—

RESISTANCE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
Conv.	7S7	—	0.5 meg	0.5 meg	50K ohm	0.5 meg	2.5 meg	100 ohm	—
I.F.	7B7	—	0.5 meg	0.5 meg	100 ohm	—	2.5 meg	100 ohm	—
Det-AF.	7C6	—	0.5 meg	10 meg	—	0.5 meg	0.5 meg	—	—
Output	7C5	—	0.5 meg	0.5 meg	—	0.5 meg	0.5 meg	330 ohm	—
Rect.	7Y4	—	0.5 meg	240 ohm	—	—	240 ohm	0.5 meg	—

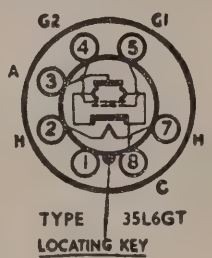
1. D.C. voltage measurements are at 2,000 ohm per volt—A.C. voltage measurements at 1,000 ohm per volt.
2. Socket connections are shown as bottom views.
3. Measured values are from socket pin to common negative.
4. Nominal tolerance on component value makes possible a variation of ± 10% in voltage and resistance readings.
5. Volume control at maximum, no signal applied for voltage measurements.
6. Resistance readings in B+ circuits may vary widely according to condition of filter capacitors.

50L6s—hard to get

★BRIMARIZE

it's a better bet

Substitute a 35L6GT for that hard-to-get 50L6GT. Both are Beam Tetrodes and both International Octals. Their characteristics are similar, except for a small difference in heater voltage. An increase in line cord resistance is all that is required to make this substitution.



RATED CHARACTERISTICS	50L6GT	35L6GT
Heater Volts	50v.	35v
Heater Current	0.15A	0.15A
Anode Volts	110v.	110v.
Anode Current	49mA	41mA
Screen Volts	110v.	110v.
Screen Current	4mA	2.0mA
Grid Bias	—7.5v.	—8v.
Power Output	2.0w.	1.5w.

CHANGE SOCKET			CHANGE CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
TYPE	FROM	TO	From Old Socket	From New Socket		
35L6GT	INT/OCTAL	NO CHANGE	NO CHANGE	NO CHANGE	Increase line cord resistance by 100 ohms (110-volt receivers) or 80 ohms (230-volt receivers.	NEGLIGIBLE

BRIMAR
RADIO VALVES

★ *OPERATION BRIMARIZE—A manoeuvre executed by qualified radio engineers in order to effect the widest possible use of available BRIMAR VALVES.*

STANDARD TELEPHONES & CABLES PTY. LTD.

AUCKLAND ..... *BOX* 571
CHRISTCHURCH ..... *BOX* 983
WELLINGTON ..... *BOX* 593
WANGANUI ..... *BOX* 293

Stolen Radios

Criminal Investigation Branch, Auckland:

Westco auto, serial No. 12409, 6 valves, D.C. Grey metallic case 12¼ in. x 7½ in. x 5¼ in., protruding dial on extreme right of set, three brown bakelite knobs underneath dial. Speaker on left hand side of set.

Cromwell audio, serial No. 3978, 7 valves, D.C. Two unit set, tuner portion 6 in. x 4 in. x 4 in., gold bronze baked enamel, slide rule dial with "Cromwell" 'engraved on plate underneath, two tuning knobs. Power supply and speaker unit 10 in. x 8 in. x 8 in., oval shape, same colour as tuner unit.

Pye radiogram, serial No. 27721, model R, portable, blue leatherette case 24 in. x 18 in. x 10 in., 230-volt, A.C., 3-speed motor, 4-valve set, centre spindle, pick-up arm, pick-up rest, three-speed control tonemaster switch, volume control, record compartment fitted in interior of lid.

Standard Mullard portable, serial No. 00502, black bakelite case, 9½ in. x 4½ in. x 6½ in., black leather carrying handle on top. Front of case opens on snap fastener automatically turning radio on. One tuning and one volume control switch.

Mullard portable, battery-electric, A.C.-D.C., mottled red leatherette covering 14 in. x 11 in. x 5 in. Serial No. 41619.

Philips 5-valve mantel model, serial No. 22035, licensed No. 15435, all-wave, brown bakelite case 18 in. x 12 in. x 8 in., slide rule dial in front at top, 4 colourless plastic knobs at front of set.

Ariel, portable, battery and electric, serial No. 3413, 6 valves, maroon colour plastic case, 9 in. x. 7 in. x 5 in., carrying handle at top with expanding spring. Three-ply base, dial covered with colourless plastic, two maroon plastic control knobs in front of set.

Police Station, Dargaville

Auburn motor-car radio, radio and speaker in one fabric covered metal box 8 in. x 6 in.; 2 in. diameter circular dial, two switch buttons at bottom.

Criminal Investigation Branch, Christchurch

350 Model Mullard radio, brown plastic case, serial No. 26035.

Philips A.C.-battery portable, 12 in. x 5 in. x 10 in.; 5 valves, two control knobs below speaker grid and full

(Concluded on Page 48.)

ACCURATE
DEPENDABLE
VERSATILE

AWA VOLTOHMYST

SOME OUTSTANDING ADVANTAGES

(1) Directly measures complex waves from 0.2 volts to 1400 volts, peak-to-peak.

(2) Has an overall accuracy for D.C. measurements of ± 3% of full scale.

(3) Measures D.C. voltage from 0.02 volts to 1500 volts. Measures D.C. current from 0.02 mA. to 1500 mA.

(4) Measures r.m.s. of sine-wave voltages from 0.1 to 1200v.

(5) Measures resistance from 0.2 ohms to 1,000 megohms.

(6) Has 7 non-skip ranges for resistance, current, and voltage measurements.

(7) All full-scale voltage points increase in a uniform "3-to-1" ratio.

(8) Frequency response flat from 30 cps. to approx. 2.5 mc. Response with Xtal probe may be extended to 250 mc/sec.

(9) Negative feedback circuit provides over-all stability.

(10) Fully-enclosed metal case shields sensitive electronic bridge from R.F. fields.

AMALGAMATED WIRELESS (ASIA) LTD.

LAMBTON QUAY, WELLINGTON (P.O. Box 830), and Room 49, Vulcan Buildings, Vulcan Lane, Auckland

3 VITAL LINKS IN THE CHAIN OF RADIOTRON SERVICE

FACTORIES IN SYDNEY (A.W.V.) & NEW YORK (R.C.A.)
NEECO
"NATIONAL ELECTRIC"-Distributors for NEW ZEALAND
RADIO SERVICE
DOMINION-WIDE NETWORK OF RADIOTRON RETAILERS

There's big news for Radiotron retailers. To supplement the range of Australian-made Radiotrons, NEECO have arranged to import supplies of R.C.A. Radiotrons to New Zealand, direct from the United States of America. So you can look forward to a far wider range of replacement valves . . . and that means more sales for you—more satisfaction for your customers.

THE **NATIONAL** NEECO **ELECTRICAL**

AND ENGINEERING COMPANY LIMITED

Auckland Wellington Christchurch Dunedin Hamilton Wanganui Hastings Invercargill

Tube Data

(Continued from Page 14.)

7.2 pF, R having a low value compared with the reactance of C. In normal operation, however, a voltage V_R occurs across the cathode resistor, so that the voltage across C is reduced by the factor $1/(1 + SR)$, in which S is the static mutual conductance of the tube. The object now is to keep the charging current of C constant, so that the effective input capacitance of C is also kept constant. In the above example the factor $1 + SR$ should therefore have a value $9.4/7.2 = 1.3$, so that, since S is 7.4 mA/V, the cathode resistor must have a value of $0.3/S = 41\,\Omega$. This resistor would indeed be required for optimum compensation of the input capacitance variation, but the result would be that the effective mutual conductance of the tube is reduced by a factor $1/1.3 = 0.77$. A lower value of R still giving adequate compensation is therefore normally used, a practical value for the EF80 being 27 Ω.

The variation in effective input resistance is also reduced by the inclusion of a non-bypassed cathode resistor. At cut-off, when the input resistance of the tube is very high, the input damping caused by the current flowing through C and R prevents the effective input resistance from reaching a very high value. However, this additional damping is also present in normal operation, so that, although the effective input resistance of the tube is somewhat increased by the effect of the negative feedback, the total effective input resistance measured across the input terminals will usually be slightly lower than that which would be obtained without a non-bypassed cathode resistor. This may be improved upon by shunting the cathode resistor by a small capacitor having a value of 5 to 10 pF.

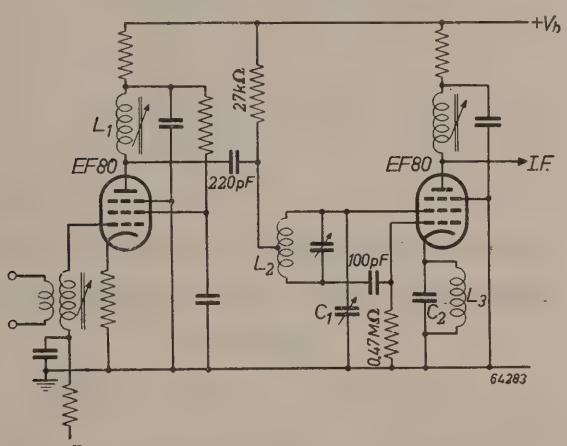


Fig. 5.—Front end for a television receiver or an F.M. receiver with one EF80 as R.F. amplifier and the other as self-oscillating frequency changer.

2. The EF80 as R.F. Amplifier

As in all R.F. amplifiers, the connecting leads should be kept as short as possible in order to minimize stray capacitance and self-inductance. The layout should be such as to reduce the risk of feedback, a centre screen of the tube holder connected to the chassis being an advantage.

Normally, common decoupling may be employed for anode and screen. If trouble is experienced due to feedback through the anode-to-grid capacitance, it may be profitable to use separate decoupling for anode and screen, as this results in a lower effective feedback capacitance. In order to obtain the highest value of input resistance the cathode pins 1 and 3 should be interconnected. In the 100 mc/sec. to 300 mc/sec. frequency bands the noise level due to static and cosmic noise is very low. The use of a triode may therefore be preferred at these frequencies.

3. The EF80 as Frequency Changer*

Fig. 5 shows a typical circuit for operation at the lower television carrier frequencies, in which the EF80 is employed as a self-oscillating frequency changer. The arrangement will be recognized as a conventional Colpitts oscillator with the coil connected between control grid and screen.

By connecting the R.F. input circuit L_1 to a point on the oscillator coil at which the oscillator voltage is a minimum, coupling between the oscillator and the R.F. input is negligible, so that there is no "pulling" of

(Continued on Page 48.)

*See *B. G. Dammers and L. J. Cock*, Comments on Frequency Changers for 30 Mc/sec to 120 Mc/sec. for TV and F.M. Receivers, Electr. Appl. Bull. *11*, p. 105, 1950 (No. 6/7).

Mullard

VALVE NEWS

VALVES FOR TELEVISION

The Valves listed below which are immediately available ex stock, are new additions to our range of MULLARD Television Tubes, and represent a further step in the MULLARD policy to remain foremost in the field of Television.

Each of these types has its own specialized application in Television circuitry, and has been the result of long and careful research by the MULLARD Laboratories.

Brief details only can be given here, but full information will be gladly forwarded on request.

EQ80—Nonode for use as F.M. Detector and Limiter. B9A base. Filament 6.3v. at 0.2 amp.

PY80—Indirectly heated booster Diode for energy recovery circuits. B9A base. Filament 19v. at 0.3 amp.

BL81—Line time base output Pentode, 8 watt. B9A base. Filament 21.5v. at 0.3 amp.

PL82—Output Pentode, 9 watt. B9A base. Filament 16.5v. at 0.3 amp.

PL83—Video Output Pentode, 9 watt. B9A base. Filament 15v. at 0.3 amp.

The Distributors of Mullard Valves and Electronic Apparatus desire to extend to all readers the Season's Greetings and Best Wishes for the forthcoming New Year.

The C. & A. ODLIN TIMBER and HARDWARE CO. LTD.

CABLE STREET, WELLINGTON

New Zealand Distributors of MULLARD Valves, Radios, and Electronic Products

BOOKS

Trade and Professional
Entertainment and Gifts

The World's Best and Latest stocked, or quickly obtained from U.S.A. or Britain

IN STOCK AND RECOMMENDED:
(*Available on 10 days' FREE Approval—please send postage*)

Radio Amateur Call Book Magazine, 1952 ..	35/–
Radio and TV Receiver Circuitry and Operation, Ghirardi & Johnson, U.S.A.	63/–
World Radio Tube Vade Mecum, 1952	33/6
Radio Aerials, E. B. Moullin	87/6
Better TV Reception in Low-signal Areas	27/6
Amplifiers, the Why and How; Briggs, etc. ..	19/9
Loudspeakers, Briggs; 3rd ed.	9/6
RADIO HANDBOOK, 13th ed. 736 pages of vital information. The world's leading reference book. 62/6.	
Antenna Manual, Smith, U.S.A.	37/6
Surplus Radio Conversion Manuals, U.S.A. ..	32/6
Magnetic Recording, S. J. Begun	37/6
Magnetic Tape Recording, Tarry	10/–
ARRIVING SHORTLY:	
The New Radiotron Designers' Handbook	57/6

SUBSCRIPTIONS ARRANGED to American or English Magazines. Send for our complete list of books on all subjects.

TECHNICAL BOOKS LTD.
11 WALTER STREET, WELLINGTON
Use this as an Order Form today!

Electrical and Radio Manufacturing Business

FOR SALE AS A GOING CONCERN

Inquiries are invited for the sale of this Business. The trademark products are recognized throughout the country as being of the finest quality. The demand is great, and the potential selling there for further expansion. In the case of a straight-out sale, the present technical directive could be retained, as this has been a big point in establishing the product and its present quality.

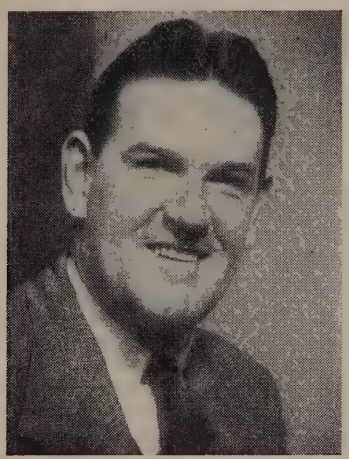
Alternatively, an offer of additional capital would be considered, preferable from someone with experience and ability on the Managerial side, who would intend to take part in the operating of the Company.

Initial inquiries, in the strictest confidence, should be by letter addressed to:

"ELECTRICAL AND RADIO"
C/o P.O. BOX 2240,
WELLINGTON.

TRADE WINDS

Transformer Co. of N.Z. Ltd.



Mr. H. Weenink

Energetic head of that growing concern, The Transformer Co., of New Zealand, Ltd., which has just moved to new premises at 78 Nelson Street, Petone, is Howard Weenink, a keen amateur radio enthusiast, ZL2TH, who hails from the South.

Achieving, as a result of his studies through the International Correspondence School, the rare distinction of becoming a registered radio serviceman while still a pupil of the Timaru Boys' High School, Mr. Weenink next opened a radio business in Timaru. Then came the call of Wellington, where he worked as a serviceman until purchasing a radio business in Petone, and later opening a second shop in Lower Hutt. Both were closed down when Mr. Weenink entered the Air Force, but, after his rejection from the Armed Services, he became Manager of Turnbull and Jones Radio Department until the end of the war. The lure of his own business soon called him again, however, and there he is still established as The Transformer Co. of New Zealand, Ltd.

This company originally commenced about seven years ago as The Domestic Appliance Co., engaged in the manufacture and distribution of radio and electrical equipment for the home. Because of accommodation difficulties, production began in a large shed and garage, but within twelve months a move was made to larger and better premises. Very soon, the business commenced to develop along different lines, when it was decided to concentrate on the manufacture of radio replacement parts, particularly transformers, and a contract was accepted from one of New Zealand's largest distributors of radio parts and accessories.

After about two and a half years, however, it was decided to terminate this contract and reorganize the company to cater for the manufacture of all types of transformers, from the smallest up to 10 k.v.a., 11 k.v. in power transformers, and special types such as current and potential transformers, etc., as well as audio types. Electronic equipment and power handling apparatus are also manufactured to meet customers' own specifications. Recently, it has been decided to stock and assemble selenium rectifier discs, as a result of which The Transformer Company of New Zealand Ltd. is now the New Zealand distributor for Salford of England and A.E.G. of Germany. It is also the New Zealand distributor for the new English Electric "C" cores and associated equipment.

Installed in its new premises, this company is now a most versatile unit, with complete facilities for production in large or small quantities.

* * *

Speakers for the Industry

When *Radio and Electronics* dropped into the newly reconditioned factory of Loudspeakers New Zealand Limited early last month, they found a hive of industry—carpenters, plasterers, painters, electricians, and engineers working furiously with a common goal—

Mr. Stan Brown.

making the first new Rola loudspeaker. By the time this issue goes to press, New Zealand-built Rola speakers will be on the market again, and we congratulate the joint staff of Swan Electric Company and the Rola Company on so quickly overcoming the hundreds of difficulties caused by loss of premises, plant, and raw materials in the Hope Gibbons fire.

We interviewed Mr. J. B. Harbort, Factory Manager of the Rola Company, Melbourne, who announced the appointment of Mr. H. M. Brown as Manager of Loudspeakers New Zealand Limited. Mr. Brown, who has been directly associated with the production of Rola loudspeakers in Australia for sixteen years, relinquished the position of Chief Inspector of the Rola loudspeaker factories in Australia to accept the managership of the new Company. Messrs. Harbort and Brown have been personally supervising the installation of the very latest type assembly jigs and machinery of which a good deal has been made specially in Australia following Swan Electric's burn-out.

Mr. Brown stated that Loudspeakers New Zealand Limited intended to make loudspeakers and their associated transformers only, and with the modern plant now in use, Rola speakers would be of a quality and economy greater than hitherto known in New Zealand. The vast research facilities of the Rola Company were

freely available and new models now being tooled for will ensure that New Zealand will not lag behind any country in the speaker field. This, combined with the advantage of having the Swan Electric Company as distributors will, we are sure, be of great satisfaction to manufacturers and retailers alike and we wish the new company every success.

Retirement of Mr. C. G. Camp.

After a distinguished secretarial career, Mr. C. G. Camp has just retired from the office of Secretary to the New Zealand Employers' Federation.

In paying tribute to his outstanding services as Secretary to the New Zealand Radio Traders' Federation for many years, the Editors of this journal recall that, due to his efforts, the radio trade first considered organizing in 1923, though it was not until 1925 that its activities came under the newly formed New Zealand Electrical Federation.

Those early days were hectic. Aerials sprang up overnight, and streets and gardens became a sea of poles. Sets, of course, were imported. Servicing necessitated the carrying of heavy batteries and travelling for miles, and the servicemen truly earned their commission.

By March, 1933, it was decided to form a separate Federation known as the New Zealand Radio Traders' Federation, to more adequately represent the interests of the radio traders.

During a recent interview, Mr. Camp recalled the great radio exhibition of 1925 held in the Wellington Town Hall, the difficulty of collecting licences, etc., and the competition with privately imported sets. There were national advertising schemes, and the great problem of co-operation with the New Zealand Broadcasting Company, and the Post and Telegraph Department, to say nothing of the headache caused by the lack of precedent over the vexed question of the marketing of radio sets. Some considered this to be the concern of electricians. Others thought Power Boards and public bodies were the logical outlet, but the idea of the latter competing with normal traders raised considerable opposition.

Even in those days the bugbear of guarantees reared its ugly head. Finally, these were limited to 90 days, but even yet there is no great unanimity on the subject.

Perhaps one of the most outstanding of all Mr. Camp's achievements was the introduction of the Radio Servicemen's Examination in 1931. As its Registrar for many years, his bold signature may be seen on certificates of registration held by many radio servicemen today. Up till March, 1940, seventeen examinations were held in all, for over 2,000 servicemen, 60 per cent. being the average number of passes per exam. If the organization had done nothing else, this effort most certainly justified its existence. After ten years' constant negotiation, the Wiremen's Registration Board finally agreed to accept the responsibility for the conduct of these examinations.

There was also the difficulty of the licence fee. For eight or nine years, dealers had paid £15 15s. or £7 10s. per annum, according to locality. At this stage, scores of unlicensed persons were dealing in radio, and the

KAWA

Pressure Cooker
For Coffee

Coffee is best when cooked under pressure. The KAWA Pressure Cooker for coffee gives the best coffee imaginable. In addition, with the KAWA method, the amount of coffee needed is considerably less than with other methods. The KAWA cooker is very easy to clean, and leaves no dregs in the coffee. Trade inquiries to—

New Zealand Distributors

H. W. CLARKE (N.Z.) LIMITED

AUCKLAND - WELLINGTON - CHRISTCHURCH - DUNEDIN

authorities were most lax in dealing with them, notwithstanding the fact that the trade reported flagrant cases month after month. In fact, it was left to the licensed dealer to police this side of broadcasting, and many long hours were spent in this work.

An addition to the many problems of those early days was that of reception. The coverage was limited, and consequently the choice of stations meagre. Those of the Broadcasting Board were supplemented by private stations, but gradually the latter were absorbed in the national coverage. The dispute over sponsored programmes finally brought about the introduction of the commercial service provided by the ZB stations.

Under Mr. Camp's able leadership, the trade alarm over patent rights and royalties was eventually overcome through the formation of a limited company to protect the patent right interest of the trade.

It would be invidious to enumerate the names of the early workers in the Federation, but those of Mr. Dave Wyles, now of Sydney, and Mr. G. W. Robertson are outstanding, and to these two men and Mr. Camp must go much of the credit for the firm foundation on which the well-organized Radio Traders' Federation is established today.

We wish Mr. Camp every happiness, good health, and prosperity in his retirement, and on behalf of the radio industry record this note of appreciation of his loyal services.

PUBLICATIONS RECEIVED

WIRELESS WORLD DIARY, 1953

Supplies are now available of the "Wireless World" Diary 1953, published by Iliffe and Sons, Limited. Size 4½ in. x 3⅛ in. wide; 80 pages of reference material, plus the usual diary pages of a week to an opening. Morocco leather, price in England, 6s. 1½d., rexine 4s. 7d. including purchase tax.

The 80-page reference section of the "Wireless World" diary, now in its 35th year of publication, provides in tabloid form the kind of technical information so often needed by the radio man, but seldom readily available. The technical data, compiled by the staff of "Wireless World" includes circuitry, useful formulae (including, for example, frequency-wavelength conversion and extending the range of meters) and graphical design data for the estimation of coil windings and circuit constants.

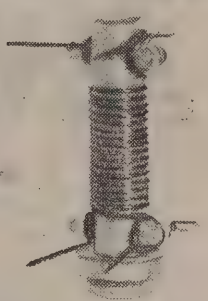
Diversity of information is a feature of the reference section, which, in addition to providing technical information, gives details of standard frequency transmissions, addresses of radio organizations (both in the U.K. and abroad) and base connections for nearly 500 current valves.

(Continued on next page.)

Do you use the "R. and E." Photographic Service? For details see advertisements in previous issues.

Poly-Q

COIL-ASSEMBLIES



Polystyrene low-loss coils throughout—adjustable iron-core slugs—fixed padders—oscillator plate tuned—temperature compensated on short-wave—A.V.C. time constant reduced on short-wave—converter ECH21—simply modified for ECH35—air tested and aligned—full instructions and circuit diagrams—easy to align—gang—dial—chassis to match.

TYPE P.44AZ DUAL WAVE TYPE P.74AZ ALL WAVE

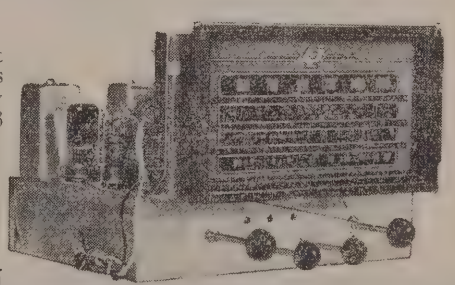
DIAL MOVEMENT D/5

Spin-wheel ball-bearing 24-1 ratio drive—glass floodlit scale—accurate calibration and station positions—effortless tuning—escutcheon in Florentine bronze window 8½ in. by 4½ in. also available—scale for D.W. SC/12, for A.W. SC/13

CHASSIS, Type 47 (to match)
GANG, Straight-line Frequency (to match)

WRITE FOR PARTICULARS

INDUCTANCE SPECIALISTS LTD.
157 THORNDON QUAY - - WELLINGTON



The Scanner, July, 1952, Decca Radar Ltd. (Electronic Navigation Ltd.)
A.P.A.E. Journal, August, 1952, Association of Public Address Engineers, England.
Maritime V.H.F. Radio Telephones, Brochure by Pye Ltd., Cambridge, England. (Green & Cooper, Ltd.)
Catalogue, Ronette Microphones, Ronette Piezo-Electric Industry. (Green & Cooper Ltd.)
G.E.C. Tele-communications, April, 1952: General Electric Co., Ltd. of England. (British General Electric, Ltd.).
Radiotronics, No. 10, October, 1952: Amalgamated Wireless Valve Co., Ltd.
Bulletin C/2011 ad. 1. Portable Microwave Television Link: Standard Telephones and Cables, Ltd.
Strowager Journal, July, 1952: Automatic Telephone and Electric Co., Ltd., England.
Westinghouse Engineer, September, 1952: Westinghouse Electric Corp., U.S.A. (H. W. Clarke (N.Z.), Ltd.)
Folder, Pope Shaver: Swan Electric Co., Ltd.
The N.Z. DX Times, October, 1952.

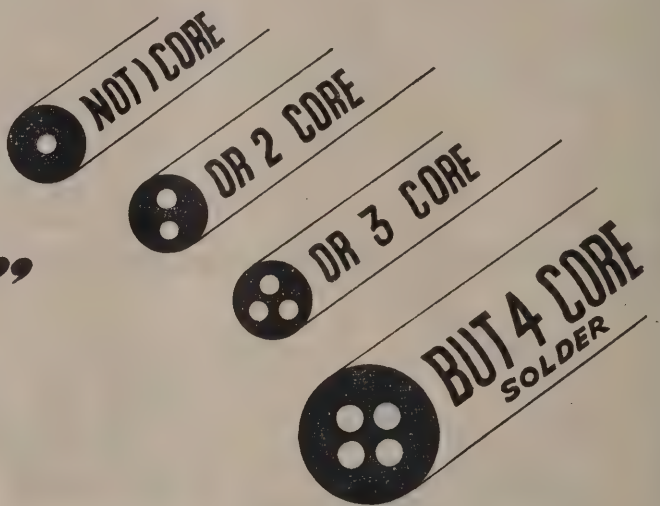
Broadcasting Greetings

We wish our many clients and friends the best reception of good luck for the Christmas Season and the best of Good Fortune for the New Year.

E.M.I. SUPPLIERS
Box 296 Phone 54-890
162–172 WAKEFIELD STREET, WELLINGTON

"The Very Latest in Resin Cored Solder"

"Tinol"



"TINOL" Solder is better, cheaper, quicker, easier to handle, clean, and odourless—a real metal solder with a non-corrosive and self-cleaning flux.

Preferred by all Electrical and Radio Industries throughout Europe **because** it combines the advantages of ordinary resin cored solder with an exceptionally strong cleansing action. Non-oxydizing, absolutely non-corrosive with the complete volatilization of the cleansing medium during the soldering process.
The "Tinol" filling will never run out when not in use, or be affected with heat, the resin tube closes automatically after each soldering job.

"TINOL" Solder is available in 13 s.w.g. or 16 s.w.g., 40 tin/60 lead, 50 tin/50 lead, 60 tin/40 lead.

Packed on 1 oz. cardboard spools for re-sale, 4 oz. tin spools for the tool-box, 1 lb. tin spools for the work bench.

WITH "TINOL" ANYBODY CAN SOLDER ANYTHING
"TINOL" AND HEAT ARE ALL YOU NEED

Available from the New Zealand Agents

J. & C. LAIRD & SONS LTD.

226-228 HIGH STREET, HAWERA

INTERNATIONALLY ACKNOWLEDGED BY ENGINEERS AS THE FINEST AVAILABLE

PICKERING *Audio Components*

Much as we would like to make Pickering Products freely available, present dollar restrictions prevent our doing so. However, we publish these details so that those interested in high-quality equipment may keep in touch with the latest Pickering developments.

For those fortunate enough to have private dollar sources, we can arrange prompt delivery.

THE PICKERING 230 H PRE-AMPLIFIER

Engineered to properly equalize the bass response of records and transcriptions and provide the necessary gain for high-quality magnetic pick-ups. Operates with any high-quality amplifier having a high-impedance input. Self-powered, and is installed simply by plugging in. Model 230 H is unique in its accuracy of equalization, and, further, the intermodulation and harmonic distortion are lower than good engineering practice requires in professional equipment.

THE PICKERING 132E RECORD COMPENSATOR

Specially developed to provide the flexibility and proper equalization of the amplifier system required to produce optimum reproduction of individual records without inherent distortion. Six switch positions correctly equalize for all of the established recording characteristics, including microgroove and standard records. Easily installed, and, like all Pickering Audio Equipment, symbolizes maximum performance.

THE PICKERING CARTRIDGE

There is a Pickering Cartridge Reproducer for every record playing and transcription use—professional, laboratory, and home phonograph. Models D-120M, S-120M, D-140S, and S-140S, with diamond (D) or sapphire (S) stylus, are without equal. They produce the finest quality reproduction of lateral recordings; they are the choice of professional audio engineers. Models D-120M and S-120M are for playing standard records and transcriptions requiring 2.5 mil. styli. Models D-140S and S-140S are for long-playing microgroove records; $33\frac{1}{3}$ and 45 r.p.m.

THE PICKERING PICK-UP ARM

The only arm capable of optimum performance on both microgroove and standard records. The Pickering 190 Pickup Arm is designed to overcome the disadvantages of all conventional arms (distortion caused by poor tracking and excessive record and stylus wear), shortcomings which have been severely accentuated by the advent of LP microgroove records. Height adjustment for turntables from $\frac{1}{2}$ in. to 2 in. high. Plug-in cartridge holder. Magnetic arm rest. Stylus point completely visible. Length, $16\frac{3}{4}$ in.

Sole New Zealand Agents

TURNBULL & JONES LTD.

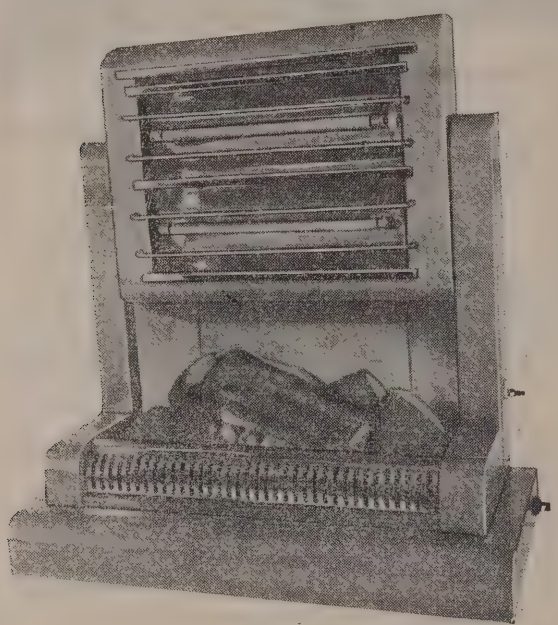
AUCKLAND, WELLINGTON, CHRISTCHURCH, DUNEDIN, HAMILTON, PALMERSTON N., INVERCARGILL

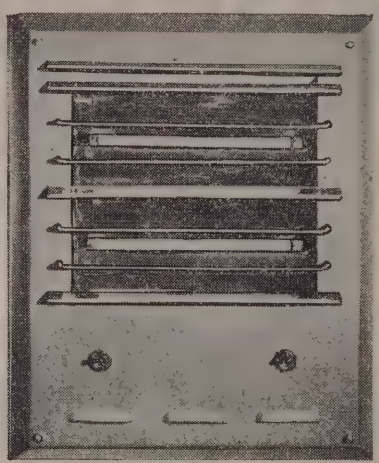
PICKERING PICKUPS AND CARTRIDGES ARE UNCONDITIONALLY GUARANTEED

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. Advertising rates are charged according to space occupied. For further particulars contact Advertising Manager, R. and E., Box 8022, Wellington.

ULTIMATE IMITATION PIN-LOG FIRE AND ULTIMATE INSET PANEL FIRE





The two new products described below will be of great interest to electrical dealers and contractors alike. The new products will not be greatly publicized, but we feel that they will be of value to dealers who wish to recommend to clients in the building profession something a little different from the normal run of radiators. Both the new fires are economical and efficient in their function.

The Ultimate Pine-log Fire has an imitation pine-log unit with flicker effect, which gives it a realistic appearance when placed in a furnished room. The fire is quite large, measuring 25in. in width and 26 in. in height. Its depth is 11 in. front to back. The body is very solidly constructed of sheet steel and is finished in a hard baked light bronze enamel. It employs two 1kw. heater bars and a convector channel at the rear of the reflectors containing a further radiator bar rated at 250 watts. The Ultimate Log Fire is a de luxe article and its reflectors and guard bars are of brass and heavily chrome plated.

The Ultimate Inset Panel Fire

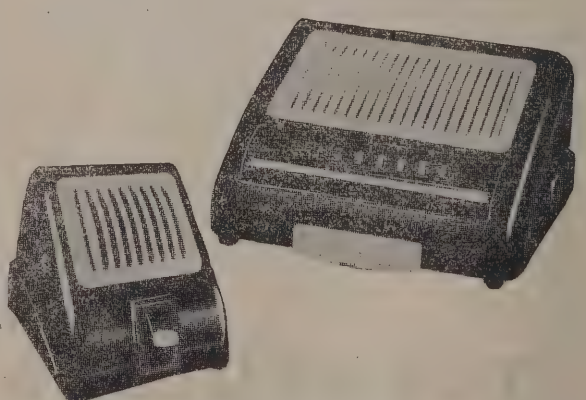
This new product is a flush fitting wall panel fire and is for permanent installation, and should have large appeal to architects, builders and home renovators.

There are two 1kw. bars giving direct heat radiation and the panel fire also uses a convector channel employing a 25-watt heater bar for effective space heating. Two switches allow independent operation of the heater bars. The body is of steel finished in baked Waihi gold enamel. The reflectors are of brass of heavily chrome plated. The size illustrated is 18 in. x 22 in., but various sizes will be made according to the size of panel required.

Both these new Ultimate top quality appliances are immediately available. Manufactured by Radio (1936) Ltd.

* * *

EDISWAN LOUDSPEAKERPHONE



The National Electrical and Engineering Co., Ltd., P.O. Box 1055, Wellington, is pleased to announce the arrival of the new Ediswan Loudspeakerphone—the most modern loudspeaker-type of intercommunication system.

Comprising a "master" unit and a number of "substation" units, this equipment provides a highly efficient method, wherever immediate person-to-person contact is required. Consequently, it is indispensable in all offices, factories, hotels, warehouses, schools, departmental stores, and hospitals.

Two standard master units are available, arranged for either six or ten, "secret" or "paging" type substation units. The "secret" type is designed so that the substation is audible to the master only when the substation key is held down, while the "paging" type is permanently switched on and is intended for use when it is desirable for queries to be received and answered without interrupting work or perhaps walking some distance.

Both types can initiate a call to the master.

All units are housed in attractive and inconspicuous black and cream bakelite cabinets.

Operation is extremely simple and maintenance and operating costs are almost negligible, being lower than the average radio receiver.

All inquiries should be addressed to any branch of National Electrical and Engineering Co., Ltd., at Auckland, Wellington, Christchurch, or Dunedin.

* * *

E.M.I. PROFESSIONAL PORTABLE TAPE RECORDER, TYPES TR.50A AND TR.50B

Messrs. H.M.V. (N.Z.), Ltd., announce the arrival of the E.M.I. professional portable tape recorders, types TR.50A and TR.50B, the distribution of which is being handled by its trade division, E.M.I. Suppliers, P.O. Box 296, Wellington, to whom all inquiries should be addressed.

Each of these models has two alternate speeds, the TR.50A operating at tape speeds of 15 in./sec. and 7½ in./sec. and the TR.50B at 7½ in./sec and 3¾ in./sec. A switched pole, two-speed motor, running truly synchronously at both speeds, is used to ensure accurate interchange of recordings.

Standard 7 in. diameter double-sided spools are used, a 1200 ft. length of recording tape giving playing times of 16 minutes, 32 minutes, and 64 minutes at the three operating speeds of 15 in., 7½ in. and 3¾ in. per second respectively.

Five-inch double-sided spools holding 60 ft. of recording tape can also be used when shorter playing times are required.

The frequency response is within ± 2 db. of the response at 1 kc/sec. from 50 cycles per second to 12,000 cycles per second at 15 in./sec.; to 8,000 cycles per second at 7½ in./sec.; and 4,000 cycles per second at 3¾ in./sec.

Fast spooling is available in either direction, a 12000 ft. spool being completely re-wound in 2½ minutes.

The input is taken from a 20 ohm. ribbon microphone, or from a 600-ohm line giving a standard level of 1 mW. + 10 db. peak. Outputs are provided to line at 1 mW. + 10 db. peak, and also to an external 5-ohm loudspeaker at 2 watts.

The operating controls, which are all mounted on the motor board, are as follows:—

(1) Replay, Stop, Monitor, Record. (This last position has a special latch to avoid accidental erasure).

(2) Spool Left, Stop, Spool Right.

(3) Record Gain.

(4) Replay Gain.

(5) Bass Cut (on microphone input) in two steps giving cuts of 5 and 10 db. at 100 cycles.

(6) Internal Loudspeaker Muting.

(7) Mains On/Off.

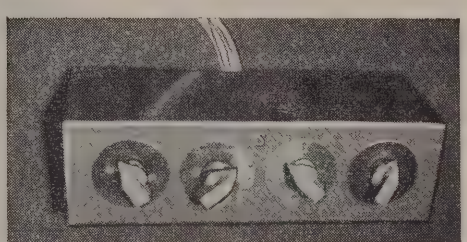
(8) Tape Speed Change-over giving visual indication of speed in use.

The complete machine weighs 59 lb. when contained in the wooden cabinet 17½ in. x 16 in. x 12¾ in. overall, covered in dark green rexine and fitted with two carrying handles.

Further details will be supplied on application to E.M.I. Suppliers, P.O. Box 296, Wellington, 162-172 Wakefield Street, Wellington.

When there's a better switch
ARCOLECTRIC will make it
New Zealand Agents
GREEN & COOPER LTD. WELLINGTON.

PRE-AMPLIFIER
By Soundmaster



This accurate, high-quality versatile unit, containing two miniature valves housed internally, has been designed to satisfy the most exacting musical critics.

It provides complete control of both radio and pick-up signals fed to the main amplifier, with full compensation for L.P. and Std. records.

TECHNICAL DETAILS:
Controls, Volume, L.P. Correction, Radio/Gram, H.F. Cut.
Frequency response, 20-20,000 c.p.s.
Input, 50-150 millivolts.
Output, 1.5 volts.
Distortion, less than 1 per cent.

PRICE, £15 12s.

Trade inquiries invited
Manufacturers:

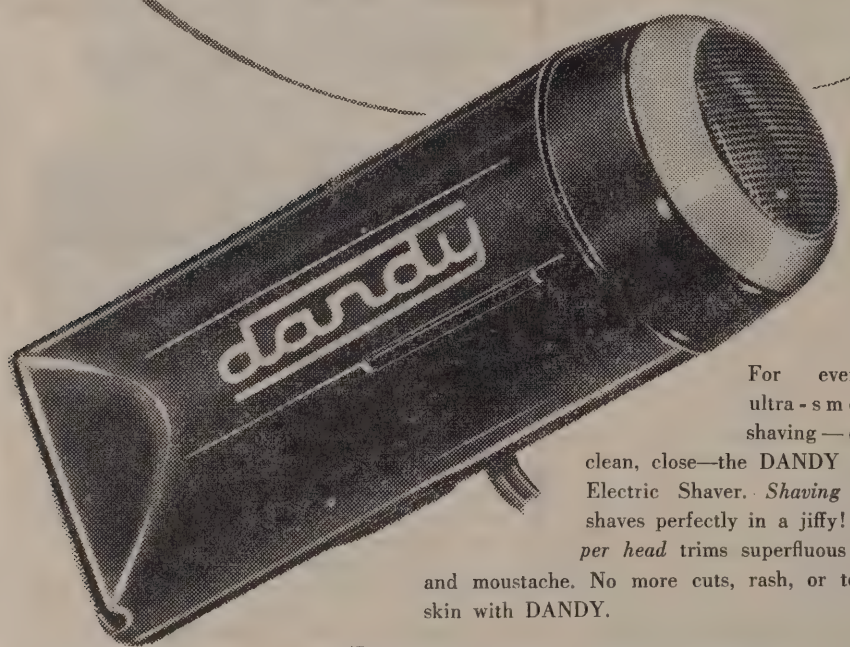
A. G. LAWFORD & CO.
ARAMOHO, WANGANUI
Sole N.Z. Agents for the famous Hartley Turner Speaker

A `DANDY'

Electric Shaver

FROM SWITZERLAND

For superior shaving ease and comfort!



UNEQUALLED VALUE

£8/10/-

For every-day ultra-smooth shaving — quick, clean, close—the DANDY Swiss Electric Shaver. *Shaving head* shaves perfectly in a jiffy! *Clipper head* trims superfluous hair and moustache. No more cuts, rash, or tender skin with DANDY.

The DANDY shaving head cuts whiskers clean and close.

The DANDY clipper head trims moustache and hair of any length.

Complete with zip leather carrying case incorporating steel shaving mirror.

12 MONTHS' GUARANTEE

dandy

The Superior Swiss Shaver

N.Z. Distributors: Russell Import Co., Ltd., P.O. Box 102, Wellington.

Proceedings of the New Zealand Electronics Institute Incorporated.

WELLINGTON BRANCH EMBARKS ON A TELEVISION PROJECT

Some two months ago it was suggested by the immediate past president of the Institute, Mr. W. L. Harrison, that the Wellington Branch should institute a television project, with the objects of providing a practical training programme for members interested in the techniques of television, and of arousing public interest in the affairs of the Institute. The suggestion was taken up enthusiastically by the Branch management committee, and as an initial step, an experimental licence was applied for. In a very short space of time the licence was granted by the Post and Telegraph Department, and the way was open to making a start as soon as possible. The project was fully discussed at the September meeting of the Branch, where considerable enthusiasm was displayed by members, and a special committee was formed to handle the project.

The chief difficulty to be overcome was the provision of a suitable place in which the physical part of the work could be carried out. The Branch does not possess club rooms, or any permanent facilities, so that a place in which to work was the first essential. Accordingly, the Television Committee directed its initial efforts to solving this problem. At the November meeting of the Branch the Committee was able to report that very satisfactory arrangements had been made with the Wellington Technical College. The Principal, Mr. Cousins, has very kindly put a laboratory at the disposal of the Branch, together with an adjoining storeroom in which gear may be stored while it is not being worked on. The Branch wishes to record its gratitude to Mr. Cousins, and to Messrs. Sukolski and Liddell of the Technical College staff, whose enthusiasm and cooperation have made these outstanding faciilties available. The Committee is of the opinion that no better place could possibly be found for carrying out the television project, and that the removal, as it were, of the first major difficulty in such a short time should enable actual construction to start early in the new year. Indeed, had plans been more advanced at the present moment (though this could hardly have been possible) there is now no reason why construction should not start immediately.

PLANNING OF THE PROJECT

The Television Committee's aims were carefully considered at its first meeting, and several important principles were laid down, with the object of implementing the project in such a way that the greatest possible number of Institute members can take part. It was considered that while a task of the magnitude contemplated could be successfully carried out only by having the project properly planned and guided by a committee, there was a distinct danger that the work would fall into the hands of a few of the most enthusiastic members, and that the majority of the Branch members might therefore be left "out in the cold." Accordingly, the following decisions were made:

(1) That any Branch member who may wish is invited to constitute himself a member of the Television Committee and attend its meetings.

(2) That at each monthly Branch meeting, the Television Committee shall report progress, and explain the reasons, technical and otherwise, behind the decisions it has made.

In this way, it is intended that the Branch as a whole shall have an opportunity of informally discussing the project and of making suggestions or proposals to the commitee. It is envisaged that in the design stages, the committee's outlines of the progress made, and its explanation of the reasons underlying the choice of the many technical features of the equipment to be built will provide most interesting material for members' consideration, and that in this way, the whole Branch will be able to take an active part in the project, even before construction has commenced.

POINTS ALREADY DECIDED

The planning of the equipment has already been started, and the following decisions have been made:

(1) The ultimate aim will be to construct a transmitter complying fully with the British standard television signal, at least as far as the form of the synchronizing waveform is concerned. Several important matters such as the polarity of modulation to be used, the polarization of the transmissions, and the method of transmitting the accompanying sound, have been left in abeyance, as there is no point in spending time on these matters at this early stage.

It will be possible to introduce variations into the final equipment which will enable things like the modulation polarity to be the subject of experiments once the equipment is operating.

(2) The equipment has been subdivided into main units, each of which will be the subject of a separate constructional programme, and it is intended to commence work in the following way.

The committee will first of all work on the paper design for the first main unit, which itself will be broken down into sub-assemblies. The purpose of this is simply to enable a number of people to work on the unit at one time, thereby providing something to do for as many members as may wish to take part in the construction, and at the same time to speed up the production of actual results, in the shape of working portions of the whole. When the paper design of the first main unit has been completed, a list will be made of the parts required, and steps will be taken to acquire these. It is expected that every member will have something to contribute in the way of equipment, even if such contributions are no more spectacular than a few resistors or condensers. When the parts for the first main unit are provided, but not until then, a start will be made on the actual construction of that unit. Meanwhile, the committee will be working on the design of the next main unit to be undertaken. The committee expects that in this way early progress will be assured, and that before long, a number of the major units will be under con-

struction simultaneously. The committee is strongly of the opinion that from now on, the rapidity with which the project can be got under way is purely a function of the number of members who are willing to devote their time and energies to it, since the arrangement with the Wellington Technical College has removed all the physical difficulties that might have been expected to crop up.

THE FIRST MAIN UNIT

(3) The first unit to be tackled will be the synchronizing unit for the transmitter. This is the most fundamental portion of the whole equipment, both theoretically and practically, and contains most of what is a characteristic only of television transmission. While it is proposed to end up with a synchronizing unit which will produce the standard British synchronizing signal, it is proposed to attack the design in such a way that in the early stages, a simple non-standard, but perfectly practicable synch. signal will be generated. This will allow a workable synchronizing system to be built *and used* very early in the constructional programme, and this will have a beneficial effect on progress. The non-standard synch. system will contain only a very few circuits that cannot be made use of for the final synchronizing unit, so that the initial "detour" will not cause any appreciable side-tracking of effort which could usefully have been applied to the ultimate gaol. The initial synchronizing system is one in which frame synch. signals are very easily separated from the line synch. signal on an amplitude basis, and is one which was used a great deal in the pre-war developmental work on television in America. It is capable of producing most precise interlace, and has been superseded for standard systems only because it is wasteful of carrier power in the transmitters. For the Institute's purposes, however, it can form a most useful technical stepping-stone towards the more complex standard system of synchronization. It is not anticipated that the non-standard scheme will be used except in the initial stages, as a means of enabling work on the receiving end to progress simultaneously with that on the transmitting side.

EQUIPMENT ALREADY DONATED

The committee is very pleased to announce that it has already received two extremely generous donations of equipment. Messrs. Standard Telephones and Cables Pty. Ltd., have offered to donate two television receiving cathode-ray tubes, to be selected from among their current types of picture tube. Messrs. D. Wareham and V. Rowe of the N.Z.B.S., have presented the Branch with two 12 in. electrostatic C.R.T.'s, V.C.R.511b. The committee would like to take this opportunity of publicly thanking those concerned for their generosity, which will be of very great assistance.

FERRANTI

2½ in. ELECTROSTATIC VOLTMETERS

Switchboard, Desk, or Portable Pattern

Suitable for use on A.C. or D.C. circuits of very high resistance where the current taken by an ordinary voltmeter would introduce considerable errors.

On D.C. there is a minute leakage current and on power frequencies and capacitance current of a few microamperes.

Range volts	Capacitance at full scale micro-microfarads
1000 - 3500	8
500 - 2500	9
300 - 1500	13
200 - 1000	20
150 - 750	22
100 - 600	30
50 - 300	55
Special Bench Model	
30 - 150	100

Sole New Zealand Agents:

ARTHUR D. RILEY & CO. LTD.

66-68 THE TERRACE, WELLINGTON 124 HOBSON STREET, AUCKLAND

BOOK REVIEWS

Elements of Radio Engineering, by H. F. Peel, M.Sc. Tech., A.M.I.E.E.; publishers, Cleaver-Hume Press, Ltd., London. Price in U.K., 10s. 6d.

Since the war there has been a considerable flow of elementary text-books, especially from America, and this one from England is the latest to add itself to the total. It is not a large book, but covers a great deal of ground in its 200-odd pages. It is primarily written for students who are studying for examinations such as Section A of the I.E.E. examination, the papers on Principles of Radio Engineering set by the British I.R.E., and 1st class P.M.G. certificate examination. It pre-supposes a knowledge of elementary electricity and magnetism, and elementary mathematics, but only of a standard comparable with our own School Certificate examinations in these subjects. It contains its own introduction to A.C. theory, and the author makes skilful use of diagrams in explaining the concepts of vectorial addition and subtraction in relation to alternating currents and voltages. At the same time, the author avoids the all too common error of hiding the wood of real understanding with the trees of too detailed and not particularly tenable analogies. This most important part of the subject is one with which students frequently have difficulty, and which, if badly taught, can prevent them from acquiring a real understanding of much of the whole subject, however glibly they may use the conventional jargon. It would have improved the chapter on alternating currents, however, if the author had made some attempt to explain the term "waveform." He launches into both verbal and graphical descriptions of a number of different types of wave without defining his sub-heading "Common Signal Waveforms," and while he is careful to provide time scales for the examples given, there is not even an arrow and a label on the ordinate scale to indicate that the waveform diagram is a graph of current or voltage versus time. Such omissions have a most unfortunate effect on the student who is trying to grasp a set of ideas that are completely new to him, and it seems a pity that such an excellent chapter should suffer in this way. However, a text-book is not necessarily supposed to replace a teacher or lecturer, and the point is not as important as it would have been, had the rest of the chapter not been so good.

In some places, the author's obvious concern with condensation of his material has led to some statements which are misleading. For instance, in dealing with the graphical analysis of the output waveform produced by a valve, he states categorically that a pentode or tetrode, which produces "rounding of both positive and negative half-waves" produces ". . . no second harmonic distortion, but only third harmonic distortion." This, of course, is just not true. A pentode or tetrode can do all this, and still produce second as well as third harmonics. No one would suggest that the author is unaware of this, but it does look as if, in order to save a few words, he has been guilty of misrepresentation. This is a case where over-simplification of an issue can give quite the wrong impression.

However, these criticisms should not be taken to reflect in any way on the general excellence of the book. It is clearly written and illustrated, and succeeds in a small space where many have failed with many more pages at their disposal. The writer can thoroughly recommend this volume to both teachers and students alike. Not the least attractive feature, these days, is the price, which is reasonable, and more in keeping with the young man's pocket than are some other texts designed for those who have just left school.

Television, by F. Kerkhof and W. Werner. Philips Technical Library.

The authors of this book are the principals of the television development laboratory of Philips Industries, Eindhoven, Holland. Its sub-title reads: "An introduction to the physical and technical principles of television, with comprehensive descriptions of various electrical circuits." As a concise statement of the contents, this could hardly be bettered. Starting with the physical principles of electronic scanning (after a short chapter which gives an outline of the complete electronic television system) the authors go on to pick-up and picture tubes, the dissection, transmission, and separation of the information contained in a scene, a chapter devoted to the principles and uses of relaxation oscillators and pulse circuits in television, the generation of time-bases, the generation of E.H.T. voltage, wide-band amplification (R.F. and video), transmission lines, aerials, photometry, lens systems, etc., colour television systems, and finally, descriptions of complete receiver circuits.

As can be seen from this list of main headings, the scope of the book is very comprehensive. The authors state that it was written in amplification of a series of lectures designed for introducing the special problems of television to men who were already competent radio engineers, and the text is of a very consistent technical level in conformity with this aim. One excellent feature is that the discussions are not confined to any one particular set of transmission standards, but take in all the operational standards at present in use, from the British and American to the 625-line C.C.I.R. standard and the 819-line French system. In common with all the Philips publications that this writer has examined, the book is not simply content with reporting and explaining standard techniques, but in many places describes the results

CRESSALL

ASBESTOS - WIRE - WOVEN RESISTANCE NETS

COST SO LITTLE

and

HELP SO MUCH

Limited number of 4-watt, 6-watt, 50-watt, and 100-watt types available ex stock.

Stocks available from

Bradley's Electrical Co. Ltd.

57 Victoria Street, Wellington
and at
57 Wyndham Street, Auckland
New Zealand Distributors for
The Cressall Manufacturing Co., Ltd.,
Birmingham, England.

of work which originated in the Philips laboratories. This has the great advantage that several technical methods are introduced to the reader, which will probably not be found in equipment currently in use in America and England, but which might well be incorporated in equipment of new design.

If there is one thing to regret about this volume, it is that more space could not have been devoted to transmitting techniques. The relatively small number of pages which do describe circuits primarily or solely to be met with in television transmitting equipment indicate that these Philips engineers probably have some very elegant new solutions to old problems, which would make very interesting reading. This is not a criticism of the authors. The book occupies over 400 pages, and packs into this space more detailed design information and explanation of basic principles than can be found in many books on the subject. Mathematics are not shunned where they are necessary, but there is also a great deal of excellently written physical explanation, and the authors make a point of providing the reader with a clearly stated exposition of the physical interpretation to be placed on the mathematical formulae which they develop. As a result, the book is perfectly readable, even by those whose mathematical equipment is not advanced enough to enable them to follow the derivations. Between them, the authors and translators have provided a refreshingly readable book, which at the same time is a mine of the sort of information that radio engineers and technicians must have if they are to become fully conversant with television circuits and principles.

FOR SALE

Vitavox G.P.1 Unit and 3-cell high-frequency Horn (brand-new)— **£17/10/-**

2 Jenson M20 1000-ohm Field EM Speakers (brand-new) **£10 each**

2 Philips 12-inch Auditorium P.M. Speakers, 40-ohm field with Transformer giving 150-ohm Voice Coil (brand-new)— **£9 each**

1 Celestian 12-inch P.M. 15-ohm Voice Coil (new)—**£10**

6 second-hand Jenson M.20 1000-ohm Field (first-class order)— **£6 each**

3 16-millimetre Machine Lenses, Taylor Hobsen wide aperture 2 in. focus— **£10**

Others, 2 in. Dallmeyers— **£6 each**

RON MERCER

GLENBROOK BEACH, R.D., WAIUKU

A TRADITION OF EXCELLENCE
FIDELITY
EFFICIENCY

GOODMANS

AUDIOM Loudspeakers

REG. TRADE MARK

The UNRIVALLED SERIES of MEDIUM and HEAVY DUTY P.M. REPRODUCERS

OBTAINABLE THROUGH ALL LEADING DISTRIBUTORS

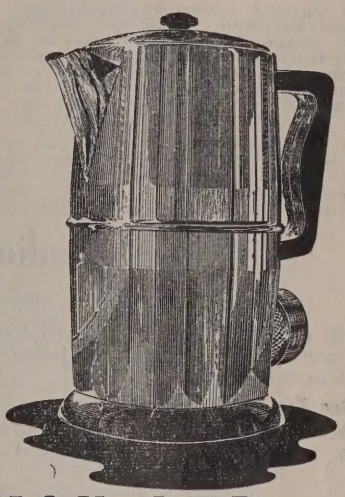
GOODMANS INDUSTRIES LIMITED

AXIOM WORKS, Wembley, Middlesex, England. CABLES: GOODAXIOM, Wembley, England.

"PANAMA" Electric Jugs

"Panama" products.

Elegance of design and skilled craftsmanship have been combined to create this new release in the long line of quality



★ Constructed of heavy gauge chromium plated copper.

★ Fitted with plastic base and handle to provide maximum insulation against heat.

★ Specially designed lid which eliminates bubbling and splashing whilst boiling.

★ Element guaranteed for two years.

Distributed by:

CORY-WRIGHT & SALMON LTD.

AUCKLAND WELLINGTON DUNEDIN

STC

STANDARD TELEPHONES & CABLES PTY., LTD.

Manufacturers of* BRIMAR *Radio Valves extend to all their friends in the radio trade heartiest Christmas Greetings and the

The Compliments of the Season

Abstract Service

(Continued from Page 28.)

for synchronizing the instruments. The system is adapted particularly for rural telephony and moving vehicle communication.
—*Electronics* (U.S.A.), August, 1952, p. 116.

TELEVISION

An improved intercarrier sound system—in this system both sound and picture carrier are amplified together through all I.F. stages. At the second detector the sound and picture carrier produce a beat signal of 4.5 mc/sec. and this carries the frequency modulated sound as well as some of the amplitude modulated picture signal, the F.M. being extracted by a discriminator circuit.
—*Radio and Television News* (U.S.A.), July, 1952, p. 36.

An investigation of how flicker can be eliminated in TV—deals with the physiology of flicker, and certain experiments with television pictures especially in relation to phospors and frame repetition rates.
—*Philips Technical Review* (Holland), Vol. 13, No. 3, p. 55.

Stolen Radios

(Continued from Page 31.)

length dial above. Covered in red leatherette with short carrying handle of same leatherette. Small V-shaped mark at one end.

Police Station, Petone

"Moderne" 5-valve, all-wave, wooden cabinet 15 in. x 15 in. x 10 in., four tuning knobs. Fairly old model.

Portable TV Link

(Continued from Page 4.)

manual gain controls. The I.F. signal is then fed through a low-impedance coaxial line to the discriminator unit where it is amplitude-limited, and demodulated by a frequency discriminator. The video signal is then amplified and fed to a cathode follower output stage.

The complete receiving end of the equipment is shown in the photograph featured on this month's cover. The control unit, I.F. unit, and discriminator unit can be situated up to 200 feet from the antenna and receiver head unit.

Vacuum Tube Voltmeters

(Continued from Page 8.)

the effect is peculiar to the circuit of our own V.T. voltmeter, and that the condenser bridging the grids would be completely effective with another voltmeter circuit. At any rate, the device does give protection from surges of one polarity, and is well worth incorporating, especially as the probe is more often connected to a positive D.C. potential than to a negative one. Even so, this does not protect the meter movement from the surge which occurs when the already charged probe is discharged by connecting it to earth.

Tube Data

(Continued from Page 33.)

oscillator frequency when tuning the R.F. circuit.

The oscillator coil L_2 is tapped at the centre, and the oscillator voltage at this point is made a minimum by adjusting the capacitor C_1 connected between the screen grid and earth. In practice it is possible to use a capacitor of fixed value for C_1.

The inductance of the oscillator coil should be small compared with that of the R.F. coil L_1, and this can be achieved by using a high Q, high C oscillator circuit, and choosing the oscillator frequency higher than the signal frequency.

The amplitude of the oscillation should be that which gives a direct voltage in the order of 2.5v. across the oscillator grid resistor. This voltage can be determined by measuring the oscillator grid current.

The input impedance of the frequency changer at carrier frequency is inherently low, mainly because the control grid is coupled to the screen. Owing to the large bandwidth employed with television this is no disadvantage. In receivers for F.M. broadcast reception, however, the required bandwidth is much smaller and the input impedance may then be increased by using a cathode capacitor C_2, which will produce a negative component of input resistance. The value of this capacitor can best be determined experimentally by starting with, for example, 500 pF and reducing this progressively. The shunt coil L_3, which is required for connecting the cathode to the chassis for D.C., should have a value of about one microhenry.

Magnetic Amplifier

(Continued from Page 10.)

amplifier makes a good non-mechanical relay or trigger capable of handling high power levels directly, finds use as a current transformer and as a translator in telemetering, may be used as a voltage regulator and as a general-purpose sensitive electronic control device controllable by phenomena as low-powered as the output of a photocell. Additional uses which are of interest are low-frequency audio amplifier, motor control, low-frequency oscillator, controlled-output rectifier, and audio modulator.

Greetings from

Cambridge Radio and Electrical Supplies Wellington

A Happy Christmas and Good Listening to all Readers.

SPECIALISTS IN A
SPECIALIZED FIELD.
MR. SERVICEMAN.
Our Universal Coils, types 40 (Aer), 45 (R.F.) and 41 (Osc) will replace any damaged R.F. Coil.
Inductance Specialists
THE N.Z. HIGH FREQUENCY SPECIALISTS
283 THORNDON QUAY, WELLINGTON, N.Z.
COILS, I.F. TRANSFORMERS, H.F. CHOKES, B.F.O.'s DIALS, SCALES, COIL ASSEMBLIES, GANGS, BUILT-UP UNITS, ETC.

For your CHRISTMAS SALES

new SHAVER for FASTER CLEANER MORE COMFORTABLE SHAVES

Pope

FEATURES

- ★ Precision diamond honed large surface cutting head.
- ★ New EZI-grip ivory body.
- ★ Attractive solid leather carrying case.
- ★ Retail price £8 8s.; normal trade discounts.

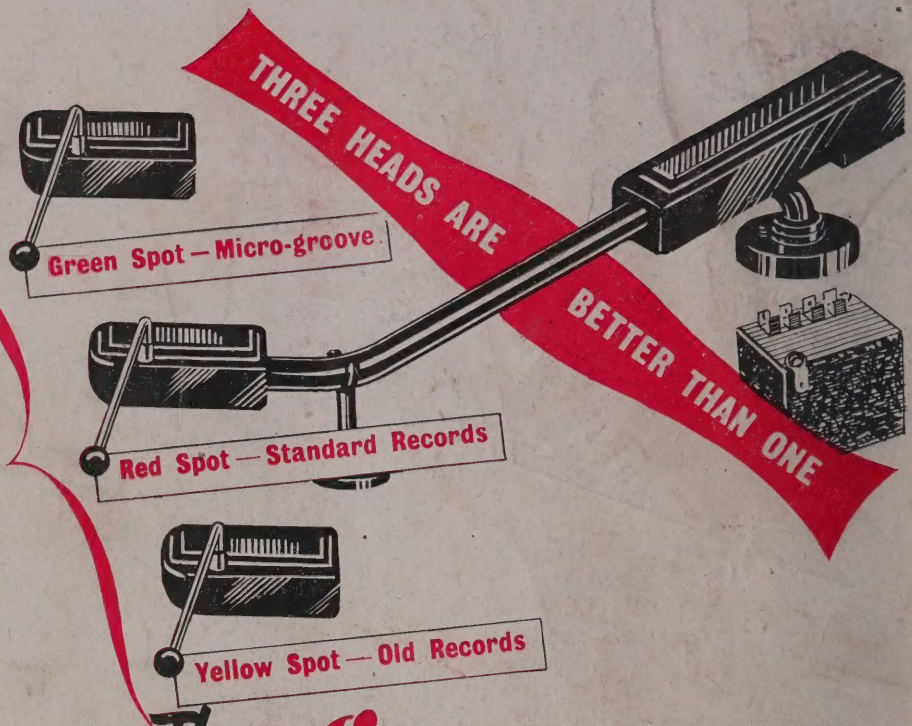
Write for Supplies and Showcards to Sole New Zealand Distributors:

Swan Electric Co. Ltd.

CKLAND - WELLINGTON - CHRISTCHURCH

"Connoisseur" . . the ideal pick-up with the ideal set-up — three bayonet-action interchangeable heads, ensuring faithful reproduction under all circumstances. Extremely low mass at needle-point, allowing reduction in downward pressure to 8–10 grams for standard recordings and 4–6 grams for micro-groove recordings. Frequency range 20–15,000 c.p.s. Ideal instrument for dubbing work on nitro-cellulose discs.

Available with or without screened step-up transformer.



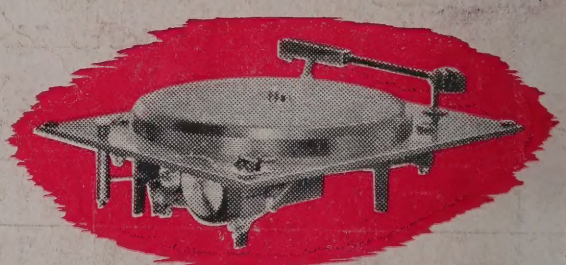
The Connoisseur

SUPER LIGHTWEIGHT PICK-UP

THE Connoisseur DUAL SPEED GRAMAPHONE MOTOR

No other motor available offers comparable quality within the generally acceptable price range.

Will play standard, transcription, and micro-groove recordings. A single turn of the switch gives either 33⅓ or 78 r.p.m. Full 12 in. diameter turntable, lathe turned from non-ferrous material. The main spindle, precision ground and lapped, runs in phosphor bronze bearings. Synchronous type motor is dynamically balanced and resiliently mounted, making it virtually vibrationless. The whole unit is mounted on a ¼ in. polished plastic board, 15¾ in. x 13½ in.



Connoisseur Products are distributed in New Zealand by

TURNBULL & JONES LTD.

Auckland Wellington Christchurch Dunedin Hamilton Palmerston North Invercargill